SOURCE CONTROL REMEDIAL ACTION REPORT

NEW HAMPSHIRE PLATING COMPANY SITE
MERRIMACK, NEW HAMPSHIRE

RESPONSE ACTION CONTRACT (RAC), REGION 1

FOR
U.S. ENVIRONMENTAL PROTECTION AGENCY

BY

TETRA TECH EC, INC.

EPA Contract Number: 68-W-98-214
EPA Work Assignment Number: 158-RARA-01G1
TtEC Project Number: 1945.2158

September 2007

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TABLE OF CONTENTS
SOURCE CONTROL REMEDIAL ACTION REPORT
NEW HAMPSHIRE PLATING COMPANY SITE
MERRIMACK, NEW HAMPSHIRE

TABLE OF CONTENTS (cont.)
SOURCE CONTROL REMEDIAL ACTION
NEW HAMPSHIRE PLATING COMPANY SITE
MERRIMACK, NEW HAMPSHIRE

TABLE OF CONTENTS (cont.)
SOURCE CONTROL REMEDIAL ACTION
NEW HAMPSHIRE PLATING COMPANY SITE
MERRIMACK, NEW HAMPSHIRE

TABLES

FIGURES

APPENDICES

ACRONYMS

%D	percent difference
µg/L	microgram per liter
ADA	Americans with Disabilities Act
AGQS	Ambient Groundwater Quality Standards
ARAR	Applicable or Relevant and Appropriate Requirements
bgs	below ground surface
COC	contaminant of concern
CRZ	contamination reduction zone
DAS	Delivery of Analytical Services
DCR	Daily Construction Report
DPA	discharge pipe area
ECI	ECI Northeast, LLC
ECTran	Excel-Crystal Ball Transport
EDI	Environmental Drilling Inc.
EECA	Engineering Evaluation/Cost Analysis
EPA	U. S. Environmental Protection Agency
EZ	exclusion zone
FS	Feasibility Study
GAC	granular activated carbon
GMZ	Groundwater Management Zone
gpd	gallons per day
GSI	Geotechnical Services, Inc.
HASP	Health and Safety Plan
HDPE	high-density polyethylene
ID	inside diameter
IDW	investigation derived waste
JCI	Jones Chemical, Inc.
LTRA	Long-Term Response Action
MCL	Maximum Contaminant Level
MEP	Multiple Extraction Procedure
mg/kg	milligram per kilogram
MOM	management of migration
NGVD	National Geodetic Vertical Datum
NHDES	New Hampshire Department of Environmental Services
NHDOT	New Hampshire Department of Transportation
NHPC	New Hampshire Plating Company
NPDES	National Pollutant Discharge Elimination System
NTCRA	Non-Time-Critical Removal Action
NWA	Northern Wetland Area
O&M	operation and maintenance
PCE	tetrachloroethene
PDI	Pre-Design Investigation
PE	performance evaluateon

ACRONYMS (cont.)

PID	photoionization detector
PPE	personal protective equipment
PSNH	Public Service of New Hampshire
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance and Quality Control
QC	Quality Control
QL	quantitation limit
RA	Remedial Action
RCMP	Risk Characterization and Management Policy
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
ROD	Record of Decision
SES	Sevenson Environmental Services, Inc.
SMSC	solidified material storage cell
SPA	Safe Plans of Action
SPLP	Synthetic Precipitation Leaching Procedure
SSI1	supplemental soil investigation 1
SSI2	supplemental soil investigation 2
SSO	Site Safety Officer
SWA	Southern Wetland Area
SWPPP	Storm Water Pollution Prevention Plan
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TCRA	Time Critical Removal Action
TtEC	Tetra Tech EC, Inc.
TtNUS	Tetra Tech NUS, Inc.
UCL	upper confidence limit
VOC	volatile organic compound
WCR	Weekly Construction Report

1

1.0 PROJECT DESCRIPTION

This Source Control Remedial Action Completion Report presents a summary of activities conducted towards the completion of the source control (soil) remedy at the Former New Hampshire Plating Company (NHPC) Superfund Site (Site) located in Merrimack, New Hampshire (Figure 1-1). The Record of Decision (ROD) for the NHPC Site (EPA, 1998) addressed the contaminated soil (source control) and contaminated groundwater underlying the Site and some adjacent properties (management of migration). This report addresses actions taken to implement the source control requirements; the actions undertaken to implement the management of migration requirements are addressed in a separate Interim Management of Migration (MOM) Remedial Action (RA) Report (TtEC, 2007a).

1.1 Site Location and Description

The NHPC Site is located in the Town of Merrimack (Hillsborough County) in south central New Hampshire and encompasses approximately 13 acres. Figure 1-2 shows the Site prior to the Source Control Remedial Action. The Site's CERCLIS No. is NHD001091453. The Site is situated at latitude 43° 51' 20"N by longitude 71° 29' 17"W. Located within the NHPC Site prior to the remedial action were: the Operations Area (where NHPC conducted its plating operations), which encompassed: the former NHPC building, a paved parking lot, and a solidified material storage cell (SMSC); and the lagoon system, which encompassed Lagoons 1, 2, 3, and 4, and the Northern and Southern Wetlands and adjacent embankments and uplands. The designations for areas of concern (i.e., lagoon or wetland) were assigned during the early 1990s, when such features existed. As the result of previous Environmental Protection Agency (EPA) and state response actions, the lagoons were neutralized and dewatered. In addition, EPA completed compensatory wetland mitigation actions in 1998 and 2002.

The Site is situated in an area with mixed land use, including light industries, commercial businesses, and a few private residential dwellings. The NHPC Site is bordered: to the south by Wright Avenue and the YMCA property; to the west by the ACME Pressure Washing (formerly Aggregate Industries) property, and several commercial/residential lots; to the north by the Public Service of New Hampshire (PSNH) property and the National School Bus Service, Inc. property; and to the east by the Jones Chemical, Inc. (JCI) property and the railroad right-of-way.

The NHPC Site and surrounding area are located on a broad stream terrace along the western bank of the Merrimack River, situated approximately 500 feet to the east. A majority of the Site (approximately 10.3 acres) is located within the 100-year floodplain, which is based on the base flood elevation of 119 feet National Geodetic Vertical Datum (NGVD) (U.S. Department of Housing and Urban Development, 1979). The storage capacity below the flood elevation of 119 feet was estimated to be 84,500 cubic yards. Portions of the Site outside the 100-year floodplain included the area containing the solidified monolith storage cell, an area along the western edge of Lagoons 3 and 4, and areas northeast and south of the Northern Wetland Area (NWA).

The NHPC Site perimeter is enclosed by an 8-foot high chain-link security fence. Access into the Site is through three gates situated at the southern perimeter, consisting of one personnel gate located along the southern fence line and two vehicle gates located at the southwestern and southeastern corners. Within the security fence, a 2,000-foot long inner chain-link fence surrounded the lagoons; access to the lagoon system was provided by three gates.

Public water service and electrical service are available on Wright Avenue. Several high voltage electrical towers are located in the northern portion of the NHPC Site, traversing the NWA in a west-east orientation. A sanitary sewer line is situated just inside the northern perimeter of the Site. A sanitary sewer line is also situated parallel to the railroad right-of-way.

The former NHPC process building area situated near the southern perimeter of the Site, had been demolished by EPA in a 1994 Non-Time-Critical Removal Action (NTCRA). The former building area was covered by a layer of high-density polyethylene (HDPE) as interim measure to minimize further leaching of soil contaminants into the underlying groundwater. The asphalt parking lot (situated west of the building area) was in a state of disrepair.

Of the four lagoons, only Lagoon 2 retained standing water. Lagoon 1 was backfilled and mounded with contaminated soil and sediment by EPA as part of a Time-Critical Removal Action (TCRA) conducted in 1990 and 1991. The mounded materials were covered with a HDPE geotextile and 2 feet of clean fill. Lagoon 1 was well vegetated at the beginning of the remedial action. Lagoons 2, 3, and 4 remained as topographic depressions; however, Lagoons 3 and 4 were extensively vegetated.

The NWA, situated in the northern portion of the Site, served as the last overflow of the lagoon system while NHPC operated. The NWA did not have standing water for most of the year and was vegetated. During the 1990 and 1991 response actions, some of the contaminated sediments were excavated from the NWA and consolidated into Lagoon 1. The PSNH has an easement for six high voltage overhead lines installed on wooden poles through the NWA. As part of PSNH's maintenance practices, the vegetation within the easement is periodically cleared.

The Southern Wetland Area (SWA) was situated near the solidified materials storage area, in the southern portion of the Site, and consisted of a small topographic depression. This area had been reworked extensively and did not have standing water during most of the year.

During a 1998 wetlands evaluation, it was estimated that only an estimated 1.44 acres of wetlands remained, degraded as the result of past waste disposal activities (TtNUS, 1998). A compensatory wetland migration action was completed by EPA and the NHDES to address the unavoidable loss of on-site wetlands and the potential loss of any remaining degraded wetlands during the Remedial Action. The mitigation consisted of the purchase and protection of the 50-acre Greens Pond wetland area in Merrimack and the 38-acre Grassy Pond wetland area in Litchfield.

1.2 Operations and Waste Management Practices

While NHPC was an active facility, from approximately 1962 to 1985, it used a variety of metals in its electroplating processes, including: cadmium, zinc, chromium, copper, lead, nickel, tin, gold, silver, aluminum, iron, and manganese. Chlorinated organic solvents used by NHPC included: trichloroethene (TCE); 1,1,1-trichloroethane; and tetrachloroethene (PCE). Cyanide was also used in the electroplating process. The use of chlorinated solvent was reportedly discontinued during the latter part of the 1970s. Electroplating wastes generated by the facility included metals, volatile organic compounds (VOCs), cyanide and acids.

Treated and untreated wastes and wastewater were discharged into various drainage channels formed within the concrete floors of the NHPC building process areas. The wastewater was then gravity-drained through an underground discharge pipe into the unlined waste lagoon system located approximately 325 feet north of the building. These lagoons occupy wetlands that developed naturally in a series of meander scars formed by the Merrimack River. Wastes were discharged directly into a primary infiltration lagoon (Lagoon 1). The lagoon system was constructed to allow the discharged wastes to overflow from the primary lagoon into a secondary infiltration lagoon (Lagoon 2) and into subsequent overflow lagoons (Lagoons 3 and 4) during periods of high discharge from the facility.

1.3 Regulatory and Enforcement History

In 1980, NHPC notified EPA that it was a hazardous waste disposal facility in accordance with Resource Conservation and Recovery Act (RCRA) Section 3001 regulations. NHPC received several Notices of Violation/Orders of Abatement for failure to comply with RCRA transportation, storage and disposal requirements, and for failure to treat its cyanide wastewater prior to discharge. Operations at NHPC ceased in November 1985.

1.4 Previous Site Investigation Activities

The Remedial Investigation (RI), completed in 1996, included the determination of contaminant nature and extent, evaluation of contaminant migration in groundwater, and assessment of risks to human health and the environment. Results of the RI indicated the presence of elevated metals concentrations in site soils and the presence of VOCs and metals at concentrations higher than groundwater quality standards in the underlying aquifer. Detailed presentations of the Site description, site history, nature and extent of contamination (as determined by the RI), and contaminant fate and transport can be found in the *Draft Final Remedial Investigation Report* (Halliburton NUS Corporation and Raytheon Engineers & Constructors, Inc., 1996). Five soil metal contaminants of concern (COCs) were identified as affecting groundwater quality: cadmium, chromium, arsenic, lead, and nickel. Cadmium is the most pervasive metal contaminant. During the RI, investigation derived waste (IDW) was stored in a wooden shed located at the southwestern corner of the solidified materials storage cell.

A Feasibility Study (FS) report (TtNUS, 1997) evaluated five soil remedial alternatives and three groundwater response alternatives. It evaluated the potential application of chemical fixation using a proprietary process to address the leaching of cadmium at the Site, the principal and representative soil COC. One component of the FS included using a computer model to estimate the potential soil leaching and groundwater transport for various metals of concern. The modeling effort produced estimates of soil concentrations that would leach metals of concern in excess of the federal Maximum Contaminant Levels (MCLs) or the New Hampshire Ambient Groundwater Quality Standards (NH AGQS).

A *Record of Decision* was issued in 1998 that identified the selected remedy to address the Site's contaminated soils and sediments and provided for the long-term monitoring of the Site's groundwater quality. More details about the ROD are presented in Section 2.0 of this report.

1.5 Prior Removal and Remedial Activities

A series of removal actions were conducted after the plant operations ceased. In 1987, the NHDES removed solutions and contaminated materials from the facility for off-site disposal, and treated sludges and process waters in Lagoon 1 with approximately 127 tons of lime and 800 gallons of sodium hypochlorite solution.

In 1990 and 1991, EPA excavated an estimated 13,600 tons of sludge and soil from Lagoon 1 and solidified the material on-site with an ash/mortar mixture. A soil berm was created north of the former NHPC building using imported clay fill which was shaped into a bowl. The soil and ash/mortar mix was placed in the berm area and allowed to solidify. The solidified material storage cell was encapsulated in a HDPE geomembrane. A clean soil cover of imported common fill approximately 2 feet thick was placed above the HDPE geomembrane and seeded. Approximately 5,000 tons of soil was also disposed at an off-site secure landfill.

An additional 5,600 cubic yards of contaminated soils were excavated from the lagoon overflow areas and consolidated into Lagoon 1. These soils were then covered with a HDPE cap and 2 feet of clean fill. Excavated areas in the other lagoons were covered with 1 to 2 feet of clean fill.

The NHPC building was decontaminated and demolished in 1994 as part of the EPA NTCRA. An underground storage tank was also removed. The footprint of the building was covered by a temporary, low-permeability, geotextile membrane to minimize infiltration and leaching. Both non-hazardous and hazardous materials generated during the building removal were disposed off site.

2

2.0 OPERABLE UNIT BACKGROUND

The selected remedy for the NHPC Superfund Site is a comprehensive approach that includes both source control (contaminated soil) and management of migration (contaminated groundwater underlying the Site and some adjacent properties) components. This section summarizes the NHPC Site remedy ROD requirements, the clean-up goals, wetland mitigation activities, and soil remedial design (RD) activities.

2.1 Requirements of the Record of Decision (ROD)

The following sections detail the requirements of the ROD and ROD cleanup goals.

2.1.1 Remedial Components

This section provides a summary description of the ROD remedial components focusing on source control.

2.1.1.1 Source Control

Implement source control for remediation of soils featuring in-place chemical fixation, excavation, on-site backfilling of treated soils, and off-site compensatory wetlands restoration. The ROD specified treatment of the metal-contaminated soil to levels which will not exceed acceptable leaching criteria (i.e., Toxicity Characteristic Leaching Procedure (TCLP), Synthetic Precipitation Leaching Procedure (SPLP) or Multiple Extraction Procedure (MEP). Untreated soils which remain in place (i.e., soils below applicable clean-up levels) cannot exceed RCRA leaching standards. The components of the overall source control remedial action include:

- Completion of a field-scale pre-design study of the chemical fixation process;
- Sequential application of the treatment reagent in 1-foot lifts down to the water table;
- Excavation of the treated soil for temporary on-site storage;
- Backfilling of all treated soil in the lagoons 1 and 2 areas;
- Grading of all other excavated areas using existing soils to the extent practical;
- Cover treated materials with a 2-foot buffer to address potential ecological concern and re-vegetate; and
- Revegetation of the remaining wetland areas with appropriate wetland type vegetation.

The ROD specified treatment of the metal-contaminated soil to levels which will not exceed acceptable leaching criteria (i.e., TCLP, SPLP or MEP).

2.1.1.2 Solidified Material Storage Cell

Perform the following remedial actions on the SMSC as part of source control:

- Crush the SMSC into small diameter fragments.

- Test the crushed fragments by TCLP. If the fragments pass TCLP, they will be placed in the treated soil backfill. If the fragments fail TCLP, they will be treated using the chemical fixation process and re-tested using TCLP. If the fragments still fail TCLP, they will be grouped for off-site disposal at an appropriate Subtitle C facility.
- Test the soils underneath the SMSC, where the building discharge pipeline was located, for contaminants of concern.

2.1.1.3 Wetland Mitigation

Because restoration or creation of new wetlands on-site would not be cost effective or practical EPA performed the following off-site wetland mitigation activities jointly with NHDES:

- Acquired the Grassy Pond wetland area in the Town of Litchfield (opposite side of Merrimack River); and
- Acquired a second wetland area in the Town of Merrimack.

2.1.1.4 Management of Migration

Implement a management of migration plan that provides protection of human health by preventing or controlling potential exposures to contaminated groundwater through the use of institutional controls. With source control in place, the groundwater quality will gradually return to acceptable levels (i.e., will meet federal and state standards) through dilution and natural geochemical attenuation. The activities to be conducted under the management of migration element include:

- Annual monitoring of selected wells within the Groundwater Management Zone (GMZ);
- Installation of two monitoring well couplets in the Town of Litchfield to determine if site-related contamination extends beyond the Merrimack River;
- Monitoring residential wells across the Merrimack River in the Town of Litchfield to determine if site-related contamination extends beyond the Merrimack River; and
- Annual sampling of surface water.

2.1.1.5 Institutional Controls

Institutional controls and monitoring will not in itself minimize off-site contaminant migration or discharge of contaminated groundwater to the Merrimack River, but in combination with source control, it will address these objectives. The institutional controls proposed include:

- Establishing a GMZ pursuant to the New Hampshire Code of Administrative Rule Env-Ws 410.26;
- Attaching restrictions, or notices as appropriate, to deeds of the NHPC property and the properties within the designated GMZ or enacting local ordinances to prohibit the potable use of untreated contaminated groundwater underlying the Site and within the GMZ;
- Attaching restrictions to the deed to assure the future property use is restricted to non-residential residential use (i.e. industrial/commercial or open space); and

- Attaching restrictions to the deed to limit any future use of the treated-backfilled cover system to activities which do not result in excavation below the 2-foot clean-fill layer.

Consistent with EPA guidance, EPA will review the Site at least once every five years after initiation of remedial action (Five-Year Review) at the Site to assure that the remedial action continues to protect human health and the environment. Implementation of the institutional controls is expected to be coordinated by the EPA and the State of New Hampshire.

2.1.2 Cleanup Goals

The following section details the soil and groundwater cleanup goals as outlined in the ROD.

The remedial action objectives for soil are:

- Minimize contaminant leaching from soils that would result in groundwater contamination exceeding MCLs, State AGQS, or acceptable human-health-based levels, and
- Prevent contact by ecological receptors with soils having contaminant concentrations exceeding the ecological risk-based performance remedial goals.

The selected soil response action includes the on-site chemical fixation treatment and backfilling of metal contaminated soils; placing crushed SMSC materials with the treated soils; placing a 2-foot soil cover system covering over the treated soil backfill; and revegetation of all disturbed areas. Former lagoon areas were previously functioning wetlands and since restoration of on-site wetlands is not possible, off-site mitigation will be performed to compensate for unavoidable impacts to the wetlands.

The remedial action objectives for groundwater are:

- Prevent ingestion of groundwater containing contaminants at concentrations exceeding drinking water criteria;
- Minimize off-site migration of contaminants in the groundwater; and
- Minimize discharge of contaminated groundwater to the Merrimack River.

The selected groundwater response action includes: implementing institutional controls, long-term monitoring of groundwater quality, and performing 5-year reviews to assess site conditions and potential risks. The monitored natural attenuation in conjunction with the proposed source controls would be protective of the environment and human health. The restoration goal for the aquifer is the natural attenuation of contaminated groundwater to below federal MCLs and the New Hampshire AGQS.

2.2 Basis for Cleanup Goals

The following sections discuss the basis used to determine the cleanup goals as part of the ROD as well as the proposed future land use of the Site.

2.2.1 Determination of Cleanup Goals

The following sections discuss the basis used to determine the cleanup goals for soil and groundwater at the Site as part of the ROD.

2.2.1.1 Soil Cleanup Levels

The soil remedial action is based on protection of groundwater and ecological receptors. In addressing these goals, the incremental risks to human health from exposure to site soils will also be mitigated. The cleanup levels must be met at the completion of the remedial action at the points of compliance which, for protection of groundwater, include all soil from ground surface to the groundwater table throughout the former lagoon area, the northern and southern wetland areas and the former building area and, for protection of ecological receptors, includes the top two feet of soil throughout the former lagoon area and the northern and southern wetland areas.

Protection of Groundwater - Soil cleanup levels were established to protect the aquifer from soil leachate. The Excel-Crystal Ball Transport (ECTran) model was used to estimate residual soil levels that are not expected to impair future groundwater quality. The interim cleanup levels for groundwater were used as input into the ECTran model and are based on MCLs and State AGQS. Cadmium is the most toxic and frequently detected soil contaminant throughout the Site and was used as an indicator to determine attainment of clean-up levels.

Location specific soil clean-up levels were developed for cadmium, ranging from 1.78 to 6.42 milligrams per kilogram (mg/kg) depending on the location of specific source areas, to account for variation in flow paths, hydrogeologic conditions and contaminant concentrations.

Ecological Risk – Using a conceptual food-web model, bioaccumulation pathways of five indicator species (red fox, short-tailed shrew, green-backed heron, American robin, and green frog) were evaluated. Cadmium was chosen as the sole contaminant of concern for all ecological receptors based on its relative toxicity and bioaccumulation potential. The ecological risk assessment concluded that exposure to cadmium soil concentrations above 5.6 mg/kg in the top 2 feet of soil would result in detrimental impacts to the short-tailed shrew.

The soil cleanup goals specified by the ROD for the NHPC Superfund Site are provided in Table 2-1.

Table 2-1
Record of Decision Cleanup Levels

Contaminant of Concern	Soil Cleanup Level (mg/kg) for Protection of					
	Groundwater Quality					Environmental Receptors[2]
	Fmr. Bldg. Area	Lagoon 1 & SWA	Lagoon 2	Lagoons 3 & 4	NWA	Shrew
Cadmium[1]	3.3	6.42	2.55	2.42	1.78	5.6

1 Cadmium was selected as the representative metal contaminant of concern; other metals less frequently detected and are likely to be co-located with the cadmium.

2 Shrew selected as representative biological receptor at risk, to 2 foot depth, only.

2.2.1.2 Interim Groundwater Cleanup Levels

Interim groundwater cleanup levels have been set based on the applicable or revelant and appropriate requirements ARARs (e.g., MCLs and AGQSs) as available, or other suitable criteria described below. When the Interim Ground Water Cleanup Levels have been achieved and have not been exceeded for a period of three consecutive years, a risk assessment will be performed on the residual groundwater contamination to determine whether the remedial action is protective.

All Interim Groundwater Cleanup Levels and final groundwater clean-up levels, if any, must be met at the completion of the remedial action in all impacted wells located within the GMZ. EPA has estimated that these levels will be obtained within 26 to 58 years after completion of the source control component (EPA, 1998).

2.2.2 Future Land Use

For the FS and the ROD, the future land use anticipated for the Site was commercial/industrial, and the exposure scenarios considered in the Risk Assessment were trespass and commercial/ industrial. However, since the issuance of the ROD, interest in reuse of the remediated NHPC Site property developed. The Town of Merrimack was provided with a Redevelopment Grant to assess the viability of reusing the NHPC Site, once remediation has been completed. Based on a Reuse Plan completed for the Site, the Town may be interested in using the remediated NHPC Site as a recreational sports field. Therefore, this possible land use was considered in the RD.

2.3 Compensatory Wetland Mitigation

An evaluation of the potential impacts of the excavation and on-site treatment of soils from the existing 2.8 acres of wetlands indicated that these resources would be unavoidably destroyed. The chemical fixation treatment process may alter the physical and chemical properties of the soils to the extent that they may no longer be suitable for use as substrata in a wetlands mitigation action. Given the potential hydrologic and hydrogeologic changes and uncertainties related to the availability of nutrient minerals in the treated soils, successful establishment of a replacement wetland system on site was unlikely.

Therefore, measures to mitigate impacts to the wetlands were implemented. In coordination with the U.S. Fish and Wildlife Service, EPA and NHDES agreed to purchase and preserve an ecologically rare and significant wetland area in the adjacent Town of Litchfield. Areas upland to the wetland, known as Grassy Pond, was purchased by NHDES in May 1998 under an agreement with EPA that allowed for reimbursement of 90 percent of the State's costs. The acquisition cost was $1.39 million. A second wetland acquisition occurred in the Town of Merrimack. Negotiations on the Green's Pond Wetland (previously unnamed and referred to as the Naticook Road Wetland) were completed by EPA, NHDES, and the Town of Merrimack in October 2002 for $254,000 (through 90 percent EPA funds and 10 percent State funds).

2.4 Remedial Design (RD) Phase

This section summarizes the RD phase which also included treatability studies and a pre-design investigation (PDI).

2.4.1 Remedial Design

During the remedial design a final grading plan based on potential recreational future use featuring a layout that included level fields, an access road, and a parking lot was developed. The criteria for Site layout were as follows:

- Retain existing site flood storage capacity;
- Consolidate the treated soil backfill to minimize the lateral extent of the cover;
- Provide level areas to accommodate future recreational fields and parking areas; and
- Meet Americans with Disabilities Act (ADA) accessibility requirements.

A majority of the Site is located in the 100-year floodplain, and the flood storage capacity below the flood elevation of 119 feet was estimated to be 84,500 cubic yards. The only area of the Site that could accommodate the fields was located in the center of the Site where most existing flood storage capacity exists. The design efforts focused on achieving a final grade elevation of 116 feet in order to provide flood storage capacity in that area as well as to maintain a hydraulic connection between storage areas to the north and south of the Site. If the fill was constructed at an elevation of greater than 119 feet, the area at the northern end of the Site would be hydraulically cut off from advancing floodwaters to the south, thereby rendering this area useless for flood storage.

The limit of the soil cover was dependent upon providing sufficient volume to accommodate the contaminated soil to be managed plus the actual material used for the 2-foot cap. In addition, the cover elevation could not exceed 116 feet, due to flood capacity issues.

Based on NHDES regulations, a 2-foot soil cover is sufficient to provide a barrier for high intensity uses that could be potentially proposed for the Site. Use of the 2-foot soil cover results in the treated materials to be classified as "potentially accessible," as defined by the NHDES *Risk Characterization and Management Policy*. Activity and use restrictions (institutional controls) are necessary to ensure the constructed remedy will not be disturbed and will remain protective.

The permeable soil cover system was designed to prevent potential erosion and to prevent potential exposure of biological receptors to the treated materials. The soil cover design consisted of: a 6-inch barrier/warning layer consisting of 2 to 4 inch rip-rap material overlain by a permeable safety orange geotextile layer to separate the treated materials from the soil cover layers, overlain by 12 inches of clean fill that will act as the vegetative support layer, and overlain by 6 inches of topsoil that will provide a suitable medium for a vegetative cover to be applied by hydroseeding or other methods. The safety orange color permeable geotextile layer provides a physical marker that separates the barrier/warning layer from the soil cover. Final grades for the flat area of the cover system were planned at 0.5 to 2 percent to accommodate future recreational activity while maintaining positive slope for stormwater runoff. The flat area slopes towards a constructed flood storage area to minimize runoff to abutting properties.

2.4.2 Bench- and Pilot-Scale Treatability Study

As part of the pre-design phase, treatability studies were implemented to assess the effectiveness of chemical fixation to reduce the leaching of selected metal contaminants of concern from Site soil to below MCLs and AGQS. Treatability study included a bench-scale study to identify candidate reagents and mix ratios and an on-site pilot-scale study to determine the effectiveness of treatment under field conditions.

The treatability study completed by Sevenson Environmental Services, Inc. (SES) indicated that chemical fixation is effective in treating Site soils and reducing leaching of metal COCs to below the ROD-specified clean-up goals. Leaching of metals from the treated soils did not exceed either the MCLs or AGQS when subjected to the SPLP. These results indicate that the soluble metal ions converted into insoluble forms do not leach when subjected to acid precipitation-like conditions and long-term acidic leaching conditions. SES implemented their pilot test using an ex-situ treatment train.

Overall, at least one treatability study identified that chemical fixation could be effective in meeting the ROD-specified treatment goals. One major finding of the treatability study was that in-place chemical fixation originally conceptualized in the FS was not viable for the NHPC Site because of the heterogeneous nature of the soils, multiple metal COCs, and the need to properly mix soil and chemical fixation reagents. Instead the Treatability study recommended ex situ treatment.

2.4.3 Pre-Design Investigation (PDI)

To support the RD preparation, a PDI was conducted by TtNUS to supplement data developed during the RI. The results of the PDI are presented in the *Draft Pre-Design Investigation Summary, Remedial Design, New Hampshire Plating Company Site* (TtNUS, 2002a).

The PDI was conducted in 2000 and 2001 to develop information necessary to complete the RD and implement the source control remedy described above. Specifically, the PDI accomplished the following:

- Developed an accurate Site base map;
- Developed an accurate estimate of the extent of contamination and the volume of contaminated soil requiring remediation;
- Verified that soil action levels established in the ROD are protective of groundwater quality;
- Characterized cyanide contamination at the Site;
- Tested SMSC materials for reactive cyanide and hazardous characteristic,
- Characterized standing water in Lagoon 2; and
- Assessed field implementation issues.

A summary of the PDI findings is presented below; details are presented in the Draft PDI Summary report (TtNUS, 2002a).

2.4.4 <u>Other Design Considerations</u>

The following items needed to be considered in the RD because these events occurred after the FS or the 1998 ROD issuance.

2.4.4.1 Risk Characterization and Management Policy

The NHDES Risk Characterization and Management Policy (RCMP) provides standards and procedures for the cleanup of sites contaminated with oil or hazardous wastes. The final version of this guidance was issued in January 1998, which occurred after the FS was completed. Therefore, the requirements of the RCMP were not considered in the FS development and were therefore not incorporated into the ROD.

Although the RCMP is a policy, the NHDES uses these standards and procedures in assessing potential health risks and identifying the need for remediation. Therefore, this policy was considered in the RD.

2.4.4.2 Arsenic MCL and AGQS revision

In February 2002, the EPA rule for a revised arsenic MCL of 10 μg/L became effective. Previously, the MCL was 50 μg/L of arsenic. The chemical fixation treatment criterion for arsenic in Site soils for the RA needed to incorporate this revised MCL. Similarly, the arsenic AGQS is expected to be revised to conform with the MCL.

2.5 Operation and Maintenance Requirements

The first ten years of Fund-lead post-source control activities are termed Long-Term Response Action (LTRA) activities, in accordance with the EPA guidance Close-out Procedures for National Priorities List Sites [EPA 540-R-98-016, January 2000]. After the initial 10-year period, the post-source control tasks are termed operations and maintenance and are implemented by the State or a designated third party.

After the completion of the chemical fixation treatment, backfilling, grading and soil cover placement, several LTRA tasks will be required to preserve the effectiveness of the remedy. The LTRA tasks include:

- General site inspection;
- Maintaining the vegetative growth and soil cover;
- Repairing the soil cover and/or adjacent areas if settlement and/or erosion occur;
- Maintaining and repairing the gravel access road;
- Assessing annually that any land use activities do not cause intrusion into the cover materials;

- Maintaining the perimeter site fencing;
- Posting and maintaining warning signs;
- Assessing storm water controls, such as swales, for vegetative cover and rip rap lining;
- Inspecting the flood storage area;
- Inspecting all slopes for settlement/slope stability; and
- Inspecting key areas of concern, such as slopes for erosion.

3

3.0 CONSTRUCTION ACTIVITIES

This section describes the construction activities undertaken to implement the source control component (soil remediation) of the NHPC Superfund Site remedy; which was performed in two phases. The Phase I site preparation activities was followed by the Phase II soil remediation and site restoration activities. TtNUS procured remediation subcontractors to perform both phases and performed construction management oversight of its subcontractor activities to ensure compliance with construction plans and specifications.

3.1 Subcontract Management and Construction Oversight

The TtNUS and TtEC construction management teams consisting of the project manager, the design engineer and resident inspectors managed the remediation subcontract and performed oversight and inspection of remedial activities on behalf of EPA. Following award of the Phase I and Phase II subcontracts, pre-construction conferences were held with the subcontractors, TtNUS, EPA and NHDES project representatives to establish lines of communication and discuss specific construction procedures.

Subcontract management activities included procedures to monitor progress and maintain systems and records to ensure work performance according to the contract requirements. Activities under this task included financial management, cost and schedule monitoring and engineering support. As part of this activity, construction progress meetings and site walkovers were held with subcontractors, TtNUS, TtEC, EPA, and NHDES project representatives on an as needed basis (usually weekly) to evaluate progress, assess conditions, identify problems, and establish action items.

Full-time oversight of the remedial action subcontractor was performed by an on-site resident inspection staff of one engineer during Phase I and two engineers during Phase II that observed the daily activities, procedures, and performed inspections on behalf of EPA. The Resident Inspectors' duties also included documenting soil excavation sample locations and results, documenting soil treatment sample results, and collecting soil excavation and treatment split samples. To ensure the remediation goals were attained the Resident Inspectors maintained excavation sample and treatment sample databases and prepared graphics using a CAD computer program to track the extent of excavation and sample locations within the contamination area. The Resident Inspectors documented ongoing field activities on frequent bases using a digital camera.

Project record keeping included preparation of a Daily Construction Report (DCR) to record weather conditions, personnel and equipment on site, meetings, site preparation activities, construction/excavation activities, soil treatment activities, soil sampling and analysis, equipment and materials deliveries and shipments, quality assurance and quality control procedures, pay items and estimates, health and safety activates, and miscellaneous project notes. A Weekly Construction Report (WCR) was prepared to summarize project status including work performed during the week, project schedule status, site preparation activities, potential problem areas/corrective actions, action items, and project activity for the next week. Each week the WCR was issued electronically to EPA and NHDES, followed by hard copy.

3.2 Phase I

Phase I of the Remedial Action was awarded to ECI Northeast, LLC (ECI) of Amherst, New Hampshire in December 2004 and completed in March 2005. Work conducted under Phase I included site preparation activities, land clearing, and demolition of the SMSC. Figure 3-1 shows the NHPC Site at the completion of Phase I. In addition, Environmental Drilling Inc. (EDI) of Sterling, Massachusetts was contracted in November 2004 to decommission 46 groundwater monitoring wells and 21 piezometers located on and off the site in preparation for remedial action activities (TtNUS, 2005d; TtNUS 2006).

3.2.1 Site Preparation

Following award of the subcontract to ECI a pre-construction conference was held with ECI, TtNUS, and EPA project representatives on 15 December 2004 to establish lines of communication and discuss specific construction procedures. The major site preparation activities consisted of land clearing and SMSC demolition, which are discussed in the following sections below. Phase I also included the following activities:

- Prepared and improved access and haul roads;
- Removed the inner fence surrounding the lagoon system and disposed of it off site;
- Removed non-energized overhead utility lines and poles and underground and surface utility lines along with all control panels/boxes and disposed of at an approved facility;
- Relocated portions of the western perimeter fence to the property boundary and installed privacy screening on the eastern perimeter fence and portions of the western and southern perimeter fences;
- Demolished a temporary shed and disposed of the demolition debris and stored investigation derived waste (IDW) off-site at an approved facility;
- Relocated a tarp-covered soil stockpiles from the treatability studies to an on-site stockpile area; and
- Installed an EPA remedial action project sign.

3.2.2 Land Clearing

As part of Phase I, clearing of trees and vegetation was performed in the southern and central portions of the Site including the PSNH right-of-way. Approximately 11 acres of the 13 acres of the Site were cleared during Phase I. No grubbing activities occurred during Phase I to avoid erosion of materials. In addition, limited clearing was performed in the Lagoons 3 and 4 and Northern Wetlands Area because of surface contamination. Clearing of vegetation within the proposed stockpiles areas consisted of clearing all vegetation to the ground surface to facilitate a level surface for stockpile laydown. All vegetation outside the identified limits of soil contamination was chipped on-site and shipped to Pinetree Power – Bethlehem, a wood-fired electric power generating plant in Bethlehem, New Hampshire. All vegetation cleared within the identified limits of soil contamination was stockpiled on-site until the remainder of clearing and grubbing activities were completed during Phase II.

3.2.3 Demolition of the Solidified Materials Storage Cell

The SMSC, or monolith, was created during the 1990 to 1991 response action to stabilize metal-contaminated lagoon sediments using a mixture of 25 percent cement. Due to the concrete-like nature of the monolith, a hydraulic hammer and large excavator (Komatsu PC1000) were required to break up the monolith materials. As part of the monolith demolition, ECI removed approximately 9,700 cubic yards (in place volume) of cover and berm soil from the storage cell. This soil was stockpiled in the eastern area of the Site for later use as backfill material. The HDPE liner that encapsulated the monolith was removed and disposed of off-site. The monolith was broken up and crushed (to minus 6-inch size) and stockpiled in the western portion of the Site for later use as backfill material in the treated soil cover system. The solidified materials stockpile was estimated to contain approximately 7,500 cubic yards of solidified materials. The stockpiles of monolith berm material and cover soils were estimated to contain approximately 3,900 cubic yards and 2,700 cubic yards, respectively.

3.3 Phase II

A single primary subcontractor was procured to perform Phase II soil remediation activities. A two-step process was used to select and procure a remediation firm to perform the Phase II remedial action activities. In the first step or prequalification step, a list of potential remediation firms qualified to perform the work was developed. The second step solicited and evaluated proposals from the pre-qualified firms. The subcontract was awarded to the qualified responsive bidder with the lowest price.

Phase II of the Remedial Action was awarded to Sevenson Environmental Services, Inc (SES) of Niagara Falls, New York in July 2005. Following award of the subcontract to SES a pre-construction conference was held on with SES, TtNUS, EPA and NHDES project representatives on 13 July 2005 to establish lines of communication and discuss specific construction procedures. The majority of on-site activities began in August 2005 and were completed in January 2007. Figure 3-2 shows the NHPC Site at the completion of Phase II. Work conducted under Phase II included:

- Mobilization and site preparation;
- Excavation of contaminated soils;
- Chemical fixation treatment of contaminated soils;
- Dewatering and water treatment operations;
- Floodwater pumping and emergency discharge activities;
- Backfilling of treated soil and soil cover installation;
- Site restoration; and
- Demobilization.

3.3.1 Mobilization and Site Preparation

In August 2005, SES began mobilization of equipment and personnel to the Site for Phase II. Mobilization and site preparation activities included establishment of temporary site support services including temporary utilities and project trailers, additional clearing and grubbing not included in the Phase I RA activities, construction of additional access haul roads and staging areas, and establishment of work zones.

Erosion and sediment control devices were installed at the Site per the SES Storm Water Pollution Prevention Plan (SWPPP), which included the construction of anti-tracking pads at the vehicle gate entrances and installation of erosion controls around the stockpile pad areas and along the haul roads to prevent migration of sediment into non-contaminated areas and/or off site.

A heavy equipment decontamination station was constructed in the southern portion of the Site and a contamination reduction zone (CRZ) was constructed between the exclusion zone (EZ) and staging area where personnel decontamination and personal protective equipment (PPE) equipment storage took place.

3.3.2 Contaminated Soils Excavation

Metal-contaminated soils excavation for chemical fixation treatment began in the southern area of the Site at the former discharge pipe area (DPA) and progressed northward in the sequence of Lagoon 1, SWA, Lagoon 2, Lagoons 3 & 4, and NWA. The former NHPC building area in the southern area of the Site was the last contaminated area excavated. Prior to beginning contaminated soil excavation the Lagoon 1 clean soil cover, estimated at 2,100 cubic yards, was removed and stockpiled on site for later use as cover/fill material.

The excavated metal-contaminated soil was transported to a central treatment area located in the southern area in the vicinity of the former solidified materials storage cell. Following chemical fixation treatment each daily batch was temporarily stockpiled and sampled. Each daily batch sample was analyzed at an off-site analytical laboratory for SPLP metals. A sample was tested weekly for TCLP metals, and 10 percent of the batches were tested for MEP metals. If SPLP and TCLP verification testing indicated satisfactory treatment, then the treated soils were used as backfill material in the soil cover area.

The HDPE geomembrane and cover material were removed from the former building area and Lagoon 1. The HDPE geomembrane was disposed of, as part the debris pile material (soil and debris mixture contaminated with plating wastewater treatment sludge residue) at the CWM Model City Facility, Youngstown, New York 14107 (permit number NYD049836679). The debris and soil mixture consisted of liner debris and other debris (wooden crane mats, concrete pieces, etc.) removed from the contaminated soil areas. The EPA pre-approved the disposal of the debris and soil mixture at the facility; according to the EPA the facility is in compliance with the condition of its operating permit. Copies of the hazardous waste manifests are provided in the supplemental RA Report data submittal.

The Remedial Design specified excavation of contaminated soils to an elevation of 102 feet, the estimated mean low water table elevation. However, due to record high rainfall during 2004 and 2005, the actual elevation of the water table elevation was significantly higher than 102 feet. The actual water table was observed at elevations ranging from approximately elevation 105 feet in Lagoon 1 up to elevation 108 feet in Lagoons 3 and 4 and the NWA. Excavating contaminated soils to the target elevation of 102 feet would have required extensive dewatering operations. Therefore, based on the soil contamination intervals, the EPA and NHDES agreed to revise the Lagoon 1 area target excavation elevation to 104 feet. Based on the water levels in piezometers installed to gauge site groundwater level and the Lagoon 1 excavation, the target excavation elevation for Lagoon 2 was established at evaluation 105 feet. The presence of a clay layer in Lagoon 2 permitted the actual excavation to an elevation of lower than 105 feet in some areas. However, in the northwest area of Lagoon 2, the actual water table encountered was higher; therefore the target excavation elevation was revised to 106 feet for that area.

From 9 May through 15 May 2006 all excavation, treatment and backfilling activities was suspended due to flooding. The flood water removal operation is discussed in Section 3.3.6.

Saturated soil conditions and high groundwater levels following the flood resulted in further target excavation elevation adjustments. Clean fill was excavated to elevation 109 feet west of Lagoon 2 instead of the planned elevation 102 feet. Groundwater levels were lower in the southern area of the Site and in the former building area excavation. Groundwater was encountered at approximately 104 feet, which was set as the target excavation elevation for that area. Based on groundwater elevations and depth of contamination, target elevations of 106 feet and 108 feet were established for Lagoons 3 and 4 and the NWA, respectively.

After completing the planned horizontal and vertical extents of excavation for the NWA, soil confirmation sampling revealed that the majority of samples collected from the excavation bottom (at elevation 108 feet) and sidewalls exceeded the NWA cleanup level of 1.78 mg/kg. Therefore, it was agreed that SES would continue the excavation of the NWA to an elevation of 107 feet and perform additional excavation of sidewalls at sample locations with cadmium levels above the cleanup level to the extent that the additional excavation is practicable. Additional excavation at locations in the vicinity of power poles and guy wires was not conducted. Also, additional excavation of sidewall locations that could potentially destabilize the slope was avoided. Following excavation to elevation 107 feet no bottom excavation confirmation soil samples were required, as the groundwater level in the NWA was approximately 107.5 feet based on measurement of water level in the closest piezometer.

A total of 94,987.8 tons of metals contaminated soil was excavated versus the projected design quantity of 91,050 tons. A breakdown of excavation quantities by area and a comparison to estimated quantities is provided in Section 5.2.1. The variance in the projected versus actual excavation quantities is due to the difference in anticipated and actual groundwater table elevations and lateral extent of contamination in each area.

3.3.3 Chemical Fixation Treatment

During the treatment activity chemical reagents were applied to the excavated contaminated soil to convert the soluble metal compounds into relatively insoluble mineral compounds that would not leach metals in excess of the MCLs or AGQS when subjected to acidic leaching tests. The chemical fixation treatment minimizes or eliminates further leaching of metal contaminants into the aquifer underlying the NHPC Site. All of the excavated metals-contaminated soil (94,987.8

tons) was treated via chemical fixation. A summary of the treatment operations is provided in Section 5.3.

As discussed in Section 2.4.2, a treatability study demonstrated that chemical fixation is effective for treating the site-specific, metal–contaminated soils. Phosphate and sulfide reagents were successfully used to prevent or reduce the leaching of arsenic, cadmium, chromium, lead, and nickel to below MCL and AGQS levels when subjected to the SPLP and MEP tests. The treatability study also concluded that ex-situ treatment was needed to ensure proper mixing of the reagents.

At the completion of excavation of the former discharge pipe area and backfilling with clean fill, the chemical fixation treatment system was set up in the area of the former solidified materials storage cell, north of the former building area, adjacent to the eastern haul road. The soil treatment system consisted of two 30-foot treatment reagent storage silos (25 ton storage capacity), a Powerscreen Turbo Commander screener plant, a Portec Pugmill with Flo-way chemical feed, and a Powerscreen stacking conveyor.

Contaminated soil was excavated from the target areas and transported via off-road dump trucks (Moxy MT31, Terex TA27, and/or CAT D350E) across the on-site Weigh-tronix automated truck scale where each load of soil to be treated was weighed and tracked. The dump trucks then either dumped their loads in one of the stockpile areas (central or southern) to await treatment, or directly at the soil treatment system for treatment. Each daily batch of soil ranged from approximately 500 tons to 1200 tons based on soil characteristics and weather conditions. An average of 700 to 800 tons of soil was treated per day.

The excavated soil was fed from a loading platform adjacent to the Powerscreen Turbo Commander into the screener at a constant rate by an excavator. After passing the first screener, the soil was transported up a conveyor belt to a hopper at the top of the Turbo Commander. The soil then entered a second hopper at the bottom of the Portec pugmill, where it was transported up a second conveyor. At the top of the pugmill conveyor, the magnesium oxide reagent was added to the soil via the Flo-way chemical feed from one of the two chemical silos at a rate of 5 to 6 percent reagent by weight based on calculations conducted by the SES treatment foreman. The chemical reagent and soil were then mixed in the pugmill, and fed up the stacking conveyor. The stockpile of treated soil coming off of the stacking conveyor was transported to one of the stockpile areas via a front-end loader. Each daily batch was stockpiled and covered pending chemical analysis.

Grab samples of treated soil were collected at 1-hour intervals and deposited into a stainless steel bowl. At the end of the daily treatment run, the grab samples were composited, and a soil sample was collected for laboratory testing. SES collected a SPLP metals sample from each daily batch, one TCLP metals sample per week, and one MEP metals sample approximately once a month. TtNUS/TtEC collected split samples randomly once per week for SPLP metals and once per two weeks for TCLP metals. MEP metals split samples were collected approximately once every two to three months of treatment.

Early in the chemical fixation process, SES encountered difficulty in obtaining regular deliveries on-site of the magnesium oxide chemical reagent. A full daily batch of chemical fixation treatment required 50 tons of magnesium oxide reagent. To avoid reagent depletion, an additional reagent storage component was added. The new storage tank allowed for an additional six loads (150 tons) of chemical reagent to be stored on-site. In addition, SES replaced the trucking company and regular deliveries were made daily to the Site.

During winter operation, equipment failures and mechanical difficulties resulted in treatment plant shutdowns and reduced daily production rates. In early January 2006, SES requested approval to change the soil/reagent mixing process from the pugmill system to a method that employed excavators and front-end loaders. SES's proposal was based on considerable experience using this method for many of their other chemical fixation projects. In addition, this method had been used previously on site to process a treatment batch due to the pugmill feeder belt breakage and this batch passed the SPLP treatment criteria. TtNUS approved the change for using the excavator soil mixing method based on results for a 2-week trial period that began 10 January 2006. The excavator soil mixing method was employed during the winter until 9 February 2006.

After the flood in May 2006, SES resumed soil treatment using excavator mixing. Manual excavator mixing was used because SES was concerned that possible caking of the reagent that sat in the silos during the flood recovery would cause uneven reagent flow from the silos resulting in ineffective soil treatment using the pugmill system.

When full-scale soil excavation and treatment resumed in June 2006, SES, with the approval of TtNUS and EPA, continued soil treatment using excavator mixing. Manual excavator mixing was utilized because SES was concerned that saturated silty soil would not pass the screening process resulting in ineffective soil treatment using the pugmill system. Due to the high percentage of saturated silty soil encountered during the remainder of the excavation and treatment process, manual excavator mixing was utilized for the remainder of soil treatment activities on-site.

3.3.4 Dewatering and Water Treatment Operations

Of the four lagoons, only Lagoon 2 continuously held standing water, with the volume of water to be removed from Lagoon 2 in support of subsequent excavation estimated at 1,200,000 gallons, subject to seasonal fluctuation, based on two dewatering events. A clay layer was later discovered in Lagoon 2, which explained the ponding of standing water.

In January 2006, SES assembled the on-site water treatment plant on the east side of Lagoons 3 and 4 and enclosed it in a temporary structure for cold weather operations. The water treatment plant featured ferric sulfate and sodium hydroxide addition, 10μ bag filters, sand filters, a granular activated carbon (GAC) unit and a 1μ bag filter. The treated water was pumped into two 20,000-gallon frac tanks, through a flowmeter and was discharged under permit from the Merrimack Wastewater Treatment Plant at a manhole located on the northern portion of the NHPC property.

As required by the wastewater discharge permit, SES collected samples of the treated water and submitted analytical results for total metals, cyanide and VOCs to the Merrimack WWTP. No exceedances of the permit limits for these constituents occurred. A daily discharge limit of 45,000 gallons per day (gpd) was initially established by the Merrimack WWTP. However, it was found that an increase was necessary to accommodate the greater volumes of water generated by the more extensive than planned dewatering operations made necessary by the significantly higher groundwater levels. SES applied for and received daily discharge limit increases to 90,000 gpd, and then to 135,000 gpd.

SES conducted a total of three dewatering events over the duration of the project as shown in the following dewatering operations summary.

Dewatering Operations Summary

Event	Dates	Gallons	Notes
1	2/2/2006 to 5/20/2006	2,496,900	dewatering surface water in Lagoon 2
2	6/21/2006 to 9/18/2006	5,430,100	post-flood dewatering operations
3	10/19/2006 to 10/31/2006	792,800	clean fill excavation dewatering operations
	Total	8,719,800	

Due to unexpected high groundwater levels resulting from historical rainfall and flooding conditions, dewatering operations produced approximately 7.5 million gallons more than the volume anticipated. Additional details regarding the dewatering and water treatment operations are provided in the supplemental RA Report data submittal.

3.3.5 Flood Recovery

From 9 May through 15 May 2006, approximately 10 to 12 inches of rainfall was received in the southeastern New Hampshire area. On 15 May 2006, Horseshoe Pond located about 600 feet to the south, and which drains into the Merrimack River, overtopped its banks, flooding the immediate area including the NHPC Site. Even though the flood water receded during the week from flood elevation of approximately 119 feet to elevation 115.9 feet, the Site is situated in a low lying area that is not free draining and an estimated 10 to 12 million gallons of standing water was left covering almost the entire Site. As a result all excavation, treatment and backfilling activities had been suspended pending flood water removal and assessment of site conditions. TtNUS and SES worked with the EPA and NHDES to obtain an emergency National Pollutant Discharge Elimination System (NPDES) permit exclusion to allow discharge of flood water to the Merrimack River.

SES used a 10-inch dry-prime diesel pump, two Godwin road-crossings, and approximately 2,500 feet of 2-inch runflat hose to remove the standing water and by pumping it to the junction of the Souhegan River and the Merrimack River. Pumping occurred on a 24-hour basis and was completed on 11 June 2006. Samples were regularly tested for VOCs and metals/cyanide as well as suspended solids visual observations.

As flood waters receded, potentially contaminated suspended silt may have transported across the Site and onto adjacent properties. Post-flood surface soil samples (0 to 0.25 feet bgs) were collected from five on-site locations (SS-01 through 05) outside of the contamination zone that were inundated by flood water and analyzed for total metals (arsenic, cadmium, chromium, lead, and nickel) and SPLP metals to determine the impact of the flooding on site contaminant levels in these areas due to possible contaminant migration. Additional surface soil sampling was performed on affected adjacent properties. No off-site contaminant migration was observed based on surficial soil sample analytical results. Metals contaminated soil that was observed in the area around the WTP in the east of the Site and along the haul road, west of the Lagoon system was delineated and removed (6-inches bgs), treated and placed in the treated soil backfill.

3.3.6 Treated Soil Backfill

After confirmatory sample results were received for each treated soil batch, and all analytical results met the cleanup goals, treated soil was backfilled into the cover area in 12-inch lifts and compacted using a smooth-drum roller. Compacted soil density was tested using a Troxler Nuclear Density Gage to confirm compliance with the remedial action specifications. For the first part of Phase II, backfill compaction testing was performed by a SES subcontractor, Geotechnical Services, Inc (GSI) of Goffstown, NH. In January 2006, TtNUS and EPA gave approval for SES to perform backfill compaction testing via a SES licensed employee and SES owned Troxler Nuclear Density Gauge.

A stabilization layer was required for the portions of the excavation that are at the water table to provide a stable base for compaction in Lagoons 1, 2, and 3/4. The stabilization consisted of 6 to 12-inches of 1 ½-inch crushed stone overlain by a geogrid geotextile layer. After the stabilization layer was placed, treated soil was placed and compacted in 12-inch soil lifts to within 2 feet of the cover finish grade.

Due to the high groundwater table, the excavation plan was revised to raise the excavation elevation in the central western portion of the Site to 109 feet and to 107 feet on the east. As a result of the excavation elevation change less backfill volume for treated soil was available in the western portion of the Site. As a result, two major changes were made in the treated soil backfill. First to make up for decreased backfill volume the former building area excavation area was utilized as a treated soil backfill area. Second, to maintain flood storage capacity and to maximize level area, a mounded treated soil fill was constructed on the eastern side of the Site along the JCI property. The mounded area runs north-south so as not to interfere with potential flow across the Site in the event of a flood.

3.3.7 Final Grading Plan, Cover System and Flood Storage

The elevated groundwater elevations not only affected the excavation plan. The final grading plan, cover system design and flood storage area design had to be modified. The revisions include the following:

- Lower finished grades at the front of the Site to increase flood storage area;
- Mound treated soil on the eastern side of the Site to accommodate reduced capacity on the western side of the Site and maintain flood storage area;
- Backfill treated soil and install a separate cover system over the backfilled soil in the

former building area excavation;

- Change the cover system limits along the western side based on the final treated soil backfill volume resulting in a decrease in cover system area;
- Revise the 18-inch thick soil cover system design from 6 inches of topsoil over 12 inches of common fill to 4 inches of topsoil over 14 inches of common fill (see Figure 3-3);
- Raise the bottom of the flood storage area to elevation 106 feet and decrease side slopes from 3:1 to 4:1 to accommodate the higher groundwater elevation and maximize stability of side slopes;
- Install a modified cover system in the flood storage area bottom (see Figure 3-3);
- Install riprap band around the bottom of the flood storage area in Lagoons 3 & 4 to stabilize the toe of slope during high water conditions;
- Raise the bottom of the northern wetland to elevation 107 feet to accommodate higher groundwater elevation and maximize stability of side slopes; and
- Construct drainage swales along the east and west sides of the mounded treated soil fill area and along the western edge of the soil cover to further facilitate drainage and to ensure that, limited or minimal runoff flows off site to adjacent properties.

The flood storage area was constructed in the former Lagoons 3 and 4 area and runs to the east to the JCI property. The flood storage area bottom was excavated to an elevation of 106 feet. A cover system was placed on the bottom of the flood storage area as a barrier to prevent contact with the residual contaminated soil remaining below elevation 106 feet. The flood storage cover system consisted of a layer of orange geofabric warning layer overlain by a 6 to 9-inch layer of rip-rap stone.

In addition, the shortage of on-site common fill realized required import of common fill and topsoil to complete soil cover installation and site restoration activities. A total of 6,110 cubic yards of common fill and 7,360 cubic yards of topsoil were imported to the Site to meet the final grades.

3.3.8 Site Restoration

As part of the Site restoration, the soil cover area was covered with 4-inches of topsoil and hydro-seeded with a turf mix designed for high-intensity recreational use. Areas outside the cover areas were hydro-seeded with a slope mix in accordance with standard New Hampshire Department of Transportation (NHDOT) specifications. Steep slopes were temporarily reinforced with erosion control matting to stabilize soil until the vegetation is established. Since the hydroseeding was performed so late in the year (November), winter rye was added in addition to the turf mixes and/or slope mixes to ensure growth of vegetation during cool weather. Additional hydroseeding was performed on selected areas in June and August 2007 after follow-up inspections revealed vegetative cover was unsatisfactory.

As part of the Site restoration, a crushed-gravel access road, approximately 640-feet long, with a six-space parking area were constructed from the main (southwest) vehicle gate along the western fence line. The main gate was replaced and the perimeter security fence was relocated to the property line along the western and northern portions of the Site. Fencing on adjacent properties was removed; however, fencing surrounding the NWA, located on JCI property, was allowed to remain to prevent access by unauthorized personnel as the narrow wetland area with steeply sloped sides presents a potential safety hazard.

3.3.9 Demobilization

In November 2006, SES began decontamination and demobilization of equipment and personnel from the Site. By December 2006, project trailers, temporary services, equipment, soil waste, and personnel were demobilized from the Site.

3.3.10 Inspections

As the work neared completion two inspections were conducted to verify that the work was complete. The pre-final inspection was conducted on 27 September 2006 to develop a punch-list of deficiencies. A pre-final inspection report summarized the deficient items and established a schedule for completion of deficient items. A final site inspection was conducted on 29 November 2006 to ensure that the deficient items were being completed.

A follow-up inspection was conducted on 3 May 2007 to verify the status of all deficiencies/work to be completed items and any other deficiencies such as areas that eroded over the winter and hydrodseeded areas not demonstrating satisfactory vegetation stands were identified for repair, regrading and reseeding as needed under the remediation subcontract warranty provisions. After completion of the erosion repairs and additional landscaping work (see Section 3.3.11), a second follow-up inspection was conducted on 20 June 2007 to verify that work was acceptable. Finally, an inspection was made on 26 July 2007 to determine if the 22 June 2007 hydroseeding was successful in establishing satisfactory vegetative cover over the erosion repair areas.

3.3.11 Landscaping and Sign Installation

In the summer of 2007 remaining work items consisting of landscaping and sign replacement were performed. Landscaping consisted of planting shrubs along a 200-foot length of the eastern perimeter security fence line opposite the JCI property for privacy purposes. On 14 and 15 June 2007 approximately 40 American Arborvitae (Thuja ocidentalis "Nigra") plants, each 6 to 8-feet tall, were planted.

Signage work, performed in August and September 2007, consisted of removing all existing "hazardous waste" warning signs attached to the perimeter security fence and installing new signs. Two site entrance signs were installed along at or near the Wright Avenue gates and a third at the PSNH easement vehicle gate. In addition, approximately 50 "no trespassing" warning signs were installed along the perimeter security fence at 100-foot spacing.

4

4.0 CHRONOLOGY OF EVENTS

This section summarizes the chronology of major events during the source control remedial action at the NHPC Superfund Site.

Source Control Remedial Action Chronology

Date	Event
5/1/1984	Discovery of New Hampshire Plating Company Site by EPA
3/4/1986	Preliminary Assessment by NHDES
1/16/1986	Site Inspection by NHDES
8/30/1989	Notice Letters issued to NHPC owners by EPA
9/7/1989	EPA removal action begins
1/5/1990	Public Notice published by EPA
11/11/1990	Expanded Site inspection by NHDES
2/21/1991	Hazard Ranking System performed by EPA
7/29/1991	EPA proposal to list site in NPL
11/27/1991	EPA removal action complete
10/14/1992	Final listing of site on NPL
10/31/1993	Engineering Evaluation/Cost Analysis (EECA) issued by EPA
10/07/1994	Non-Time Critical Removal Action (NTCRA) begun on former NHPC building by EPA
1/31/1996	NTCRA completed
9/28/1998	Remedial Investigation/Feasibility Study (RI/FS) completed
9/28/1998	Record of Decision (ROD) issued by EPA
6/24/2002	Compensatory Wetlands Purchase completed by EPA
12/30/2002	Remedial Design (RD) completed by EPA
8/24/2004	Remedial Action (RA) begun by EPA
11/24/2004	Monitoring well decommissioning begun
12/15/2004	Monitoring well decommissioning complete
12/21/2004	Phase I of RA begun
2/1/2005	Phase I clearing complete
2/24/2005	Solidified materials storage cell demolition completed
3/18/2005	Phase I demobilization
8/1/2005	Phase II of RA mobilization begun
8/8/2005	Phase II site preparation begun
9/7/2005	Excavation and staging of contaminated soils begin
9/12/2005	Chemical fixation soil treatment plant set up
10/3/2005	Chemical fixation pilot test begun
10/20/2005	Full-scale chemical fixation treatment begun
12/1/2005	SWA soil excavation and treatment completed
1/10/2006	Modified (excavator mixing) chemical fixation treatment begin (winter operations)
2/6/2006	Water treatment plant winterization and start-up
2/25/2006	Lagoon 2 dewatering begun
3/28/2006	Excavation, treatment, and backfilling of soil resumed
4/13/2006	Lagoon 1 soil excavation and treatment completed
5/15/2006	Flood event; Flood water removal begun
6/21/2006	Soil excavation, treatment, and backfilling resumed after flood event
7/14/2006	Lagoon 2 soil excavation and treatment completed
7/29/2006	Former Building Area soil excavation and treatment completed

Date	Event
8/23/2006	Lagoons 3 & 4 soil excavation and treatment completed
8/31/2006	Discharge Pipe Area 4 soil excavation and treatment completed
9/15/2006	NWA soil excavation and treatment complete
10/2/2006	Cover system construction begun
10/6/2006	Flood storage area construction begun
12/4/2006	Cover system construction and site restoration completed
12/18/2006	Demobilization complete
1/26/2007	Perimeter security fencing modifications completed
6/22/2007	Erosion repairs and landscaping completed
2/12/2007	As-Built plan completed
8/1/2007	Entrance signs installation completed
9/5/2007	Warning signs installation completed

5

5.0 PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL

This section provides a detailed analysis of performance standards and construction quality control associated with the remedial action activities including a summary of excavation and chemical fixation analytical results per cleanup area compared to the cleanup goals established in the ROD.

5.1 Supplemental Investigations

Two supplemental investigations were performed during the soil remediation activities. At the completion of the demolition of the SMSC, a supplemental soil investigation (SSI1) was performed to determine the nature and extent of contamination in the discharge pipe area beneath the SMSC. Sample results were used to define the limits of contamination prior to the start of Phase II. The SSI1 report is provided in the supplemental RA Report data submittal.

In March 2006, a second supplemental soil investigation (SSI2) was performed to determine the nature and extent of contamination in the areas outside the extent of contamination not previously sampled in the former operations area in the southern portion of the Site. No areas were identified as a risk to human health or the environment. The SSI2 report is also provided in the supplemental RA Report data submittal.

5.2 Excavation Performance Comparison to Cleanup Goals

This section provides a summary of excavation quantities and confirmation samples results compared to the cleanup goals established in the ROD. Complete excavation confirmation analytical results are provided in a separate submittal.

5.2.1 Quantity of Soil Treated

A total of 94,987.8 tons of metals contaminated soil was excavated for treatment via chemical fixation. Table 5-1 provides a summary of treatment quantities per area and a comparison to estimated quantities to be excavated. The volume of soil excavated from each area was determined by the Phase II remedial subcontractor surveyor. The variance in the projected versus actual excavation quantities is due to the difference in anticipated and actual groundwater table elevation and lateral extent of contamination in each area.

Table 5-1
Metal-Contaminated Soils Excavation Summary

Area	Projected Soil Excavation (tons)	Actual Soil Excavated[1] (tons)	Percentage of Projected
SWA and DPA	13,500	12,682.2	94%
Lagoon 1	16,500	22,876.0	139%
Lagoon 2	35,100	27,595.8	79%
Lagoons 3 & 4	14,250	14,519.1	102%
NWA	2,700	7,027.0	260%
Fmr. Bldg. Area	9,000	10,199.4	113%
Total	**91,050**	**94,897.8**	**104%**

[1] Excavated quantities are based on scale readings.

5.2.2 Excavation Confirmation Soil Sample Collection and Analysis

The Phase II remediation subcontractor collected a total of 403 confirmatory cadmium samples (plus QC samples) from the excavations sidewalls to ensure that all of the contaminated soil has been excavated in accordance with remedial action contract technical specifications vertical and horizontal locations were surveyed by the Subcontractor.

The soil excavation confirmation samples were composite soil samples collected from the sidewall at intervals of 25 feet on center. At each sample location, the composite sample was prepared by obtaining soil aliquots at a 2-foot interval along a vertical transect from the bottom to top of excavation. Typically the length of the vertical transect range from 6 to 14 feet, therefore the number of soil aliquots typically obtained from each sample location ranges from four to eight.

TtNUS collected split samples from the remedial subcontractor to verify their analytical results. A total of 34 samples (plus QC samples) were submitted by TtNUS to Mitkem Corporation in Warwick, Rhode Island for total cadmium, arsenic, chromium, lead and nickel analysis. Soil excavation split-sample collection and analysis was performed in accordance with the Phase II Soil Remediation Quality Assurance Project Plan (QAPP) (TtNUS, 2005a).

Complete soil excavation confirmation samples results are provided in the supplemental RA Report data submittal.

5.2.3 Excavation Confirmation Soil Sample Results Evaluation

This section presents a summary of the evaluations conducted on excavation confirmation soil sample results to verify attainment of the cleanup levels for the NHPC Site soil remediation. The ROD specified clean-up levels for cadmium ranged from 1.78 to 6.42 mg/kg, depending on the location of specific source areas as discussed in Section 2.2.1.1. The ROD did not specify a soil cleanup level for the DPA located between Lagoon 1 and the NHPC former building area. Since the flow paths and hydrogeologic conditions for the DPA are more similar to Lagoon 1 area than the former building area it was determined that the Lagoon 1 cleanup levels were appropriate for the DPA.

To determine whether the lateral extent of each area's excavation had attained the required clean up level, a statistical analysis of the sidewall soil sample results was performed. The approach is based on the assumption that most of the soil exceeding the cleanup level, including the soil with the highest cadmium concentrations, had been excavated such that the upper confidence limit (UCL) of the mean cadmium concentration in the remaining soil is at or below the cleanup level. The 95 percent UCL equals or exceeds the true mean 95 percent of the time. The 95 percent UCL of the arithmetic mean accounts for the uncertainty in estimating the true mean of an environmental data set and provides reasonable confidence that the true mean will not be underestimated.

Statistical methods for determining whether the mean concentration of the site is less than a cleanup standard presented in Methods for Evaluating the Attainment of Cleanup Standards (EPA 230/02-89-042) Chapter 6 assume that the contaminant concentrations follow a normal distribution, and calculate an UCL based on the Students-t statistic. The Lagoon 1 Area/SWA excavation sidewall soil cadmium concentration data set was analyzed using a TtNUS-modified version of EPA's ProUCL (Version 3.00.02, August 2004) software. This software calculates the 95 percent UCLs using 15 different computation methods, 5 parametric and 10 non-parametric. ProUCL then suggests which UCL is most appropriate for the data set.

Using the mean as the basis of comparison to the cleanup level involved the following procedures for handling certain data as follows: 1) replicate and duplicate sample results were averaged; 2) less-than–detection-limit (non detects) values were included in the analysis at the reporting detection limit; and 3) all data not known to be in error was considered valid.

A summary of the excavation confirmation soil sample cadmium concentration statistical analysis results for each excavation area except the NWA is presented in Table 5-2. The evaluations of the excavation areas confirmation soil sample results are provided in Appendix A. The NWA excavation confirmation soil sample cadmium concentration statistical analysis is presented in the following section.

Table 5-2
Soil Excavation Confirmation Cadmium Results Analysis Evaluation
(units: mg/kg)

Variable	DPA	Lagoon 1 Area/SWA	Lagoon 2	Lagoons 3 & 4	Fmr. Bldg. Area
Samples (number)	19	34	34	39	21
Cleanup Level	6.42	6.42	2.55	2.42	3.30
Mean	3.70	2.99	0.95	0.89	1.37
Median	3.0	2.4	0.5	0.5	0.53
Minimum	0.94	0.094	0.15	0.044	0.058
Maximum	13	21	6.2	4.5	5.4
Std. Deviation	2.79	3.69	1.15	0.92	1.51
Variance	7.79	13.6	1.33	0.84	2.27
Approx. Gamma UCL[1]	4.92	4.09	--	--	2.16
Chebyshev UCL[1]	--	--	1.81	--	--
99% Chebyshev UCL[1]	--	--	--	2.35	--

[1] UCL value provided is most appropriate for the data set.

As shown, the calculated mean of cadmium analytical results for all areas except the NWA is lower than the area cleanup level indicating that the cleanup level for that area was attained. To account for the uncertainty in estimating the true mean of each area's data set the 95 percent UCL for each data set was calculated using ProUCL software. The software determines if a data set follows a normal distribution and calculates the most appropriate UCL for that data set. The true mean of the excavation sidewall soil cadmium concentration is probably equal to or less than the UCL value. Except for the NWA, the UCL values for all areas are less than the cleanup level indicating, with reasonable assurance, that the cleanup level for each area's sidewall excavation sidewall was attained.

Split samples collected by TtNUS were analyzed by a Delivery of Analytical Services (DAS) laboratory for arsenic, chromium, lead, and nickel. The level of these metals in the 14 split samples of residual soils (remaining soils left in place) for the areas listed in Table 5-2 are below the cleanup levels specified for these metals.

5.2.4 NWA Excavation Confirmation Soil Sample Results Evaluation

NWA excavation confirmation sampling included the bottom as well as the sidewall since the target excavation elevation of 108 feet was anticipated to be above the groundwater level. However, after completing the planned horizontal and vertical extents of excavation for the NWA, soil confirmation sampling revealed that the majority of samples collected from the excavation bottom (at elevation 108 feet) and sidewalls exceeded the NWA cleanup level of 1.78 mg/kg. Therefore, the NWA excavation continued to an elevation of 107 feet and additional sidewall excavation at sample locations with cadmium levels above the cleanup level was performed to the extent practicable. Following excavation to elevation 107 feet no bottom excavation confirmation soil samples were required, as the groundwater level elevation in the NWA was estimated at 107.5 feet.

However, after excavating 7,027 tons of contaminated soil from the NWA, 4,327 tons more than planned by the remedial design, it was determined that the cleanup level could not be attained without causing significant structural damage to adjacent properties. The additional cost for the remaining untreated soil excavation and required property restoration was estimated at $434,400.

Statistical analysis of confirmation testing results found that the average cadmium concentration in residual untreated soils in the NWA is 3.92 mg/kg. Based on the NWA residual untreated soils cadmium concentration of 3.92 mg/kg, a new ECTran groundwater model run estimated that the maximum concentration at the river resulting from the NWA residual contamination at 0.5 µg/L. Based on the previous modeling runs for the entire plume, the concentration at the river for cadmium decreased from 5.13 µg/L at year 56 to 4.68 µg/L at year 58. Since the maximum contribution from the NWA residual concentration is only 0.5 µg/L, and the concentration was predicted to drop 0.45 µg/L over the 2-year time step, the effect of the aquifer cleanup time at the river would be minimal (about 2 years) and within the accuracy of the model (TtEC, 2007b).

Since extensive engineering and construction resources, significant additional costs, and considerable project schedule extension would be required to meet the 1.78 mg/kg level with no change in timeframe for achieving natural attenuation, EPA determined that that to the extent practicable, best efforts had been made to achieve the cadmium clean-up level in the NWA. EPA, therefore, revised the NWA cleanup level or protection of groundwater to 3.92μg/kg.

Since cadmium soil levels at three sidewall sample locations were significantly higher that the ecological clean up level of 5.6 mg/kg, a partial cover was placed over these locations to prevent access by ecological receptors. The average cadmium concentration of the NWA uncovered residual untreated soils is 2.06 mg/kg, lower that the 5.6 mg/kg ecological clean up level.

Split samples collected by TtNUS were analyzed by a DAS laboratory for arsenic, chromium, lead and nickel. The level of these metals in the 5 split samples of residual soils (remaining soils left in place) in the NWA are below the cleanup levels specified for these metals.

5.3 Treatment Performance Comparison to Cleanup Goals

This section presents a summary of the evaluations conducted to verify that the soil treatment levels designated in the ROD were achieved during the chemical fixation processing of the excavated soils. Metal-contaminated soils excavated from designated areas of concern were treated in batches and stockpiled while treated soil confirmatory sampling and analysis was conducted. The remedial subcontractor was required to test the metal leachability of one composite sample for each daily batch using the SPLP, test one sample weekly using the TCLP and test 10 samples using MEP during the treatment operations. The MEP test was performed for information purposes to demonstrate that the chemical fixation process treatment is permanent and effective in the long term.

The metal-contaminated soil will be treated to meet the remediation goals for the five metals of concern (arsenic, cadmium, chromium, lead, nickel) established in the ROD. To demonstrate attainment five metals in the SPLP leachate could not exceed the federal MCLs or the New Hampshire AGQS for arsenic, cadmium, chromium, cadmium, lead, and nickel (see Table 5-3). In addition, the five metals of concern in the TCLP leachate (analyzed using SW-846, Method 6010B) could not exceed the requirements of 40 CFR 264.24 (Toxicity Characteristic).

Table 5-3
Soil Treatment Requirements

Metal	SPLP Leachate Limits (μg/L)	SPLP Leachate Limits Basis	TCLP Leachate Limits (μg/L)
Arsenic	10	MCL	5,000
Cadmium	5	MCL	1,000
Chromium	100	MCL	5,000
Lead	15	MCL	5,000
Nickel	100	AGQS	NA[1]

Prior to full-scale production four soil treatment test runs were conducted using batches of untreated soil excavated from Lagoon 1, Lagoon 2, SWA and DPA and stockpiled in the southern stockpile area. Approximate test run batch quantities ranged from 500 to 858 tons. Both SES and TtNUS submitted treated soil samples from each of the four test run batches for SPLP and TCLP metals analyses. The test run sample TCLP analyses conducted by SES's laboratory subcontractor, Alpha Analytical, indicated all test run treated soil samples passed the TCLP were considered valid and were used as the basis of TtNUS approving full scale operation by SES.

5.3.1 Treatment Confirmation Analytical Results Evaluation

A total of 112 SPLP and 48 TCLP treated soil samples were collected by the remediation Subcontractor. In addition, 10 treated soil samples were tested using the MEP.

Split samples were provided by the Subcontractor to TtNUS to verify the remediation Subcontractor's analytical results. TtNUS collected 36 treated soil split-samples (approximately one sample per week) for SPLP-metals testing, 22 samples for TCLP-metals testing (approximately one sample per 2 weeks) and 3 samples for MEP-metals testing to verify the remediation Subcontractor's analytical results. In addition, TtNUS collected 16 total metals and cyanide samples to document the treated soil characteristics.

Soil treatment split- sample collection and analysis was performed in accordance with the Phase II Soil Remediation QAPP (TtNUS, 2005). During treatment startup system periods additional samples for SPLP-metals and TCLP-metals testing were collected. In addition, samples collected for TCLP-metals testing were also analyzed for total metals to obtain more comparable results.

A summary of the treatment confirmation soil sample collection is provided in Table 5-4. All SPLP and TCLP leachate metals samples, including TtNUS split samples, met the applicable soil treatment goals. Two samples (one of treated SWA soils and one from Lagoon 2 treated soils SW-11 and L2-08) initially failed SPLP due to leachate lead concentrations reported above the treatment goal of 15 μg/L; however, the verification sample collected passed SPLP for lead after reanalysis. Treated samples were analyzed using MEP for informational purposes.

Table 5-4
Soil Treatment Confirmation Test Summary

Area	Treatment Batches	No. Treatment Batches	SPLP Tests	TCLP Tests	MEP Tests
SWA/DPA	SW-01/-13 PD-01/-03	16	18	8	1
Lagoon 1/SWA	L1-01/-36	36	39	18	3
Lagoon 2	L2-01/-35	35	35	8	1
Lagoons 3 & 4	L3-01/-16	16	16	3	1
NWA	NW-01/-08	8	8	2	1
Fmr. Building Area	BA-01/-12	12	12	2	0
	Total	**123**	**128**	**41**	**7**

Complete soil treatment analytical results are provided in the supplemental RA Report data submittal.

5.4 Construction Quality Assurance and Quality Control (QA/QC)

This section provides a detailed discussion of the QA/QC requirements for the remedial action, any substantial problems or deviations from those QA/QC requirements, and an assessment of data quality.

5.4.1 Approved QA/QC Requirements

The following sections describe the QA/QC requirements for analytical sampling and for construction/remedial activities.

5.4.1.1 Analytical Quality Control Requirements

Two types of Quality Control (QC) checks and samples were utilized for this project: batch-specific and sample-specific. Batch-specific QC checks included QC samples that were handled, prepared, and analyzed concurrently with the environmental samples. The data were used to ensure the proper procedures used to collect, transport, and analyze a batch of samples were performed under known, well-defined conditions. Sample-specific QC was used to evaluate potential sources of error in the collection, transport, and analysis of individual samples. The type and frequency of laboratory quality control checks are defined by the methods utilized.

5.4.1.1.1 Sampling Quality Control

The following field quality control samples were collected to monitor the quality of the soil sampling performed at the NHPC Site. TtNUS collected split samples to confirm the remedial subcontractor results.

Rinsate Blank: Rinsate blanks or equipment blanks, used to assess the effectiveness of decontamination procedures, were collected at a rate of 1 in 20 samples.

Field Duplicates: Field duplicates were submitted at the rate of 1 for every 20 samples. Field duplicates of the confirmation soil excavation were collected as co-located samples. Field duplicates of the confirmatory treated soil were collected as split samples.

Performance Evaluation (PE) Samples: PE samples, used to assess laboratory accuracy, were collected at a rate of 1 for every 20 samples for total metals and cyanide analyses.

5.4.1.2 Construction Quality Control Requirements

This section discusses the activity-specific procedures and inspection activities that were performed by the construction management personnel to ensure the on-site source control remedy was constructed properly and in a manner that protects the surrounding environment.

Resident Inspectors observed the Subcontractor's activities on a daily basis to determine conformance of materials with approved shop drawings and compliance with the construction drawings and specifications, sound construction practices, and safety-related activities.

The Resident Inspectors and Site Safety Officer (SSO) recorded daily notes and observations in field notebooks. The information recorded included weather conditions, sampling details, unusual events, field measurements, etc. The Resident Inspector recorded pay quantities daily and reviewed the tabulated quantities with the Subcontractor's representative.

If the Resident Inspectors observed non-conformance work, the remedial Subcontractor was informed and a request was made that the non-conformance be resolved and corrective action taken in a manner that was approved by TtNUS. Non-conformance work included work that TtNUS determined to be not conforming to the Construction Drawings and Technical Specifications. The Project Manager documented the non-conformance and corrective action through correspondence with the Subcontractor until the non-conformance was resolved.

A final inspection of all work completed by the Subcontractor was conducted by the Resident Inspector as components were completed and prior to demobilization. The purpose of the inspection was to ensure the completed work meets or exceeds the provisions of the drawings and specifications.

5.4.1.2.1 Site Clearing and Grubbing

Evaluation and acceptance of the Site clearing, grubbing, chipping, and screening work was based on visual observations and review of sampling results by the Resident Inspectors.

5.4.1.2.2 Excavation and Stockpiling

Evaluation and acceptance of the Site excavation and stockpiling activities was based on visual observations, in-place testing of materials, and review of Subcontractor soil excavation sample and TtNUS split sample analytical results by the construction management staff.

5.4.1.2.3 Soil Treatment

Metal-contaminated soils excavated from designated areas of concern were treated in batches and stockpiled while confirmatory sampling and analysis was conducted.

Once analytical data had been received to confirm attainment of treatment goals by SPLP and TCLP, the treated materials were transported to designated on-site locations to be used as backfill. If the analytical results indicated that treatment goals were not met, then the batch would be retreated and retested.

Evaluation and acceptance of the Site excavation and stockpiling work was based on visual observations, in-place testing of materials, and review of sampling results by the construction management staff.

5.4.1.2.4 Backfilling and Grading

The Site layout includes green space, a parking lot, and an access road. The primary goals were to achieve the following in backfilling and grading the Site:

- Retain existing flood storage capacity;
- Consolidate contaminated soil to minimize lateral extent of the cap; and
- Provide a level area to accommodate green space and parking areas.

Backfilling of treated soils and monolith materials was contained within the limits of the soil cover shown on the as-built plan and per the typical soil cover section detail on the Contract Drawings. Clean soil material was backfilled in areas shown on the as-built plan. Backfilling and compaction of materials was performed in accordance with the content technical specifications.

Grading of the Site was to the elevations shown on the contractor drawings, and was verified in the field by the Subcontractor's surveyor. Final grades are one-half (1/2) to two percent to accommodate recreational activity while maintaining positive slope for drainage.

Evaluation and acceptance of the backfilling and grading work was based on visual observations, in-place testing of materials, review of sampling results, and survey information by the construction management staff.

5.4.1.2.5 Soil Cover

A 2-foot soil cover was installed to meet the RCMP for high intensity use of the facility. The cover was placed over the treated soil backfill area. The soil cover consists of a 6-inch barrier/warning layer consisting of larger diameter aggregate material overlain by a permeable orange geotextile layer to separate the treated materials from the soil cover layers overlain by 14 inches of clean fill that will act as the vegetative support layer overlain by 4 inches of topsoil that provides suitable medium for vegetative cover.

The soil cover is sufficient to provide a barrier for high intensity recreational use. The soil cover was designed to prevent potential erosion and to prevent potential exposure of biological receptors to the treated materials.

Evaluation and acceptance of the soil cover work was based on TtNUS' review of the Subcontractor's material, in-place material testing, and visual observation by the Construction management staff.

The cover area was seeded with a permanent cool weather seed mixture in accordance with contract specifications, with the addition of winter rye due to cold weather seeding. Areas outside the cover area were seeded with a slope NHDOT slope mix.

5.4.2 Substantial QA/QC Problems or Deviations

Due to the duration of the MEP metals analysis (14 days) and the limited on-site stockpile area, it was determined the MEP metals analysis would not be used as a treatment goal to keep excavation, treatment, and backfill activities from being delayed. MEP metals samples continued to be collected for informational purposes only and a summary of all MEP metals samples is provided in the Supplemental RA Report data submittal.

5.4.3 Assessment of Performance Data Quality

This section discusses the evaluation of the Subcontractors results through comparison with individual oversight split sample analytical results and data sets.

5.4.3.1 Individual Sample Analytical Results Comparison

To assess the comparability of the oversight split sample results with the remediation subcontractor's results, the percent difference (%D) was calculated for each detected analyte greater than four times the quantitation limit (QL) for the excavation confirmation metals results. No %D calculation was performed for the treatment soil samples. Thirty oversight excavation confirmation split samples were collected. When compared with the remediation subcontractor's results 23 of the sample results were determined to be comparable. The majority of treatment soil samples analyzed for SPLP and TCLP metals were reported as non-detect values, therefore no significant statistical analysis can be made. The individual sample analytical results comparisons are provided in the supplemental RA Report data submittal.

5.4.3.2 Data Set Analytical Results Comparison

The remediation Subcontractor's and split-sample data sets were compared by performing sample t-test and linear regression using the split excavation confirmation samples. A summary of the data set analytical results comparison is included below.

In accordance with Section 20.2.2 of the QAPP, a paired t-test was run on the cadmium split-sample datasets. The t-test assumes a normal distribution. EPA's ProUCL software was used to determine the distribution of the datasets. It was determined the cadmium data were not normally distributed; however, the natural logarithms of the cadmium data were normally distributed. The t-test was therefore performed on the natural logarithms of the cadmium results. The absolute value of the t statistic (1.397) was below the critical two-tail t statistic (2.352); therefore, the null hypothesis, that both datasets have the same mean, was not rejected. The t-test calculations are provided in the supplemental RA Report data submittal.

6

6.0 FINAL INSPECTION AND CERTIFICATIONS

This section describes the final inspection performed as part of the source control remedial action and discusses adherence to health and safety requirements.

6.1 RA Contract Inspections Summary

This section describes the final inspection performed as part of the RA.

6.1.1 Pre-Final Site Inspection

On 27 September 2006, representatives from TtEC, SES, USEPA, and NHDES conducted a pre-final site inspection following the weekly progress meeting. A final punch list was developed consisting of the work remaining to be completed.

6.1.2 Final Site Inspection

As part of the Remedial Action for the Site, a final site inspection was performed on 29 November 2006 after site work was deemed substantially completed by TtEC.

6.1.2.1 Attendees

The following representatives from TtEC, SES, USEPA, and NHDES were present during the final site inspection:

James Forrelli, TtEC Project Manager
Arnold Ostrofsky, TtEC Region 1 Deputy Program Manager
Liyang Chu, TtEC Remedial Design Project Manager
Brandon Smith, TtEC Resident Inspector
Brett Kay, TtEC Resident Inspector
Chris Nadeau, TtEC Lead Remedial Design Engineer
Kurt McAllister, SES Site Superintendent
James Chow, USEPA Region 1 Work Assignment Manager
Tom Andrews, NHDES Project Manager
Richard Pease, NHDES Superfund Site Manager

6.1.2.2 Deficiencies/Work to be Completed Identified

The items identified during the inspection are listed in Table 6-1. As part of the final site inspection, a photograph log was taken of all noted areas with deficiencies requiring action and work remaining to be completed as part of the remedial action. The inspection photographs are provided in the supplemental RA Report data submittal.

Table 6-1
Deficiencies/Incomplete Work Items Identified During Final Inspection

Item	Description
1.	The chain-link fence along the Jones Chemical, Inc (JCI) and NHPC site boundary remains to be installed, and the temporary security fence on the JCI property removed.
2.	The drainage swale along the southeastern and southern slope of the berm area requires installation of erosion control matting and 6-inch rip-rap.
3.	The chain-link fence along the Aggregate Industries property and NHPC site boundary remains to be installed, and the temporary security fence on the Aggregate Industries property removed.
4.	Common fill grading, placement of topsoil, and hydroseeding remains to be completed in the southern portion of the Site.
5.	Southern portion of the berm area remains to be hydroseeded. Erosion control matting remains to be installed on the slopes of the berm area.
6.	Privacy screening along the JCI property fence remaining to be removed and disposed of offsite. Erosion control matting remains to be installed on the slopes of the berm area.
7.	Due to heavy rains prior to installation of erosion control matting on the northern end of the berm area, soil eroded from the slopes was deposited in the southern end of the flood storage area.
8.	The area under the PSNH power lines, adjacent to the NWA and flood storage area, was previously hydroseeded. However, due to additional work in the NWA and heavy rains, the hydroseed is not present and will require another application for adequate vegetative growth
9.	The area under the PSNH power lines, adjacent to the NWA and flood storage area, was previously hydroseeded. However, due to additional work in the NWA and heavy rains, the hydroseed is not present and will require another application for adequate vegetative growth.
10.	Rill and gully erosion points were identified along the southern slope of the NWA due to heavy rains and resulting runoff.
11.	Rill and gully erosion points were identified along the west hillside due to heavy rains and resulting runoff to the flood storage area.
12.	Rill and gully erosion points were identified along the west hillside due to heavy rains and resulting runoff to the western swale.
13.	Rill and gully erosion points were identified along the western swale due to heavy rains and resulting runoff to the western swale and already saturated soil conditions.
14.	Areas in the southwestern corner of the cover system were previously seeded but will require application of hydroseeding.

6.1.2.3 Corrective Actions and Follow-Up Inspections

Following the final site inspection, all deficiencies requiring action and work remaining to be completed as part of the Remedial Action were discussed with TtEC's Remediation subcontractor, SES. All deficiencies were corrected and work to be completed were performed by SES. TtEC provided continued inspection of areas identified and provided updates to USEPA and NHDES as to corrective actions performed.

A follow-up inspection was conducted on 3 May 2007 to verify the status of all deficiencies/work to be completed items and any other deficiencies such as areas that eroded over the winter and hydrodseeded areas not demonstrating satisfactory vegetation stands were identified for repair, regrading and reseeding as needed under the remediation subcontract warranty provisions. After completion of the erosion repairs and additional landscaping work (see Section 3.3.11), a second follow-up inspection was conducted on 20 June 2007 to verify that work was acceptable. Finally, an inspection was made on 26 July 2007 to determine if the June 2007 hydroseeding was successful in establishing satisfactory vegetative cover over the erosion repair areas.

6.2 Adherence to Health and Safety Requirements

The TtNUS and SES Health and Safety Plans (HASPs) were adhered to throughout the project. This included an initial site orientation and health and safety meeting to describe the requirements of the HASPs to all on-site personnel prior to commencement of work activities at the beginning of the project (or when a new individual first arrived on site). In addition, a daily tailgate safety meeting was conducted with all on-site personnel prior to the day's activities. The tailgate meeting included discussion of the day's activities, potential hazards, proper PPE for the tasks, and a review of SES Safe Plans of Action (SPAs) for each activity. All personnel were required to sign-off on the SPAs for each activity daily to indicate they had been briefed and understood the potential hazards.

Both TtNUS and SES health and safety personnel performed daily air monitoring for VOCs via a photoionization detector (PID) or multi-gas meter. Dust levels were monitored during all daily activities, and regular dust suppression activities were performed when required based on instrument readings and/or visual observations of dry conditions. No action levels for either VOCs or dust were exceeded during the duration of the project. In addition, SES performed periodic noise monitoring around heavy equipment and the treatment areas to determine whether hearing protection was required for personnel working around the equipment.

On 28 September 2006, TtEC's health and safety officer was on site to conduct a health and safety audit. A few minor H&S issues were noted, which the SES Site Safety Officer and the TtEC Resident Inspectors corrected. No major H&S issues were noted during the audit.

On 7 November 2006, a local union laborer, strained a shoulder muscle while moving rolls of geofabric in the afternoon. The strain was reported to the SES Site Safety Officer , and an incident report was completed and filed with SES HSO Paul Hitcho. The union laborer returned to work on 8 November 2006 and was assigned light to medium duty until medically cleared by his physician for full duty. The SES Site Safety Officer reviewed the SPA for safe lifting practices, including mechanical assistance for heavy and/or bulky loads during the morning tailgate H&S meeting. According to the Site Safety Officer, the incident was not an OSHA reportable incident since it was not a time-loss injury.

7

7.0 OPERATION AND MAINTENANCE (O&M) ACTIVITIES

This section describes operation and maintenance (O&M) activities associated with the source control remedial action and potential problems or concerns with O&M activities. O&M activities related to the groundwater remedial action are addressed in the Management of Migration Interim RA report.

7.1 Post-Construction Operation and Maintenance Activities

This section describes operation and maintenance (O&M) activities associated with the remedial action.

7.1.1 Operation Activities

No operation activities, including scheduled operating events and unscheduled operating events are required for the source control remedy.

7.1.2 Maintenance Activities

Maintenance includes the routine inspection of cover components, site features, scheduled maintenance events, and unscheduled maintenance events. Maintenance and inspections of the cover and its components should be conducted by a designated representative. Also included is record keeping of all inspections and maintenance events conducted by the designated representative.

7.1.2.1 Site Entry and Exit

Access to the NHPC Site is restricted to the access gates located on Wright Avenue. Gates are to remain locked at all times and only authorized personnel are permitted on-site. The designated representative along with EPA, and/or NHDES will have access to the Site.

7.1.2.2 Inspection and Maintenance Records

Inspections will be held quarterly for the first two years and documented on the Inspection Log Sheet. The log sheets from all inspections will be filed with EPA and NHDES. Supplemental inspections may be performed immediately following significant storms or unforeseen events that may compromise the integrity of the remedial measures. Inspections will be held annually after the second year of operation. Once an inspection has been conducted, any maintenance work recorded should be performed within one month of the inspection.

7.1.2.3 Quarterly Inspections and Maintenance

Quarterly inspections will be conducted on each cover component and site features for the first two years. Specific items are detailed in the following sections for the vegetated cap surface, soil cover settlement, site fencing and posted signs, and monitoring wells. Inspections will change from quarterly to annually after the second year of operation.

7.1.2.3.1 General Inspection

A general site inspection will be conducted for general trash/debris, signs of any dumping activities, and overall site conditions.

7.1.2.3.2 Vegetative Growth

A successful maintenance plan for the cover is dependent upon visual inspections of the Site. The intent of inspections is to protect and maintain the integrity of the cover to eliminate any potential exposure of materials beneath the cover. A designated representative will perform the required inspections and maintenance work as described in this section. Required maintenance identified by the inspections should be performed by qualified contractors in a timely manner following the inspections.

The surface of the modified 13-acre site was graded using clean fill. If the grading deviates from the original post-closure site conditions, then regrading, reseeding, refertilization will be needed as necessary.

Temporary erosion control matting installed on the steep slopes will provide initial soil stabilization until grass cover is established. The matting will have to be inspected during the material's useful life and repaired and /or replaced, if necessary.

The vegetative cover will be inspected and maintained. The vegetation is designed to limit erosion of the topsoil, thereby maintaining the integrity of the soil cover. The vegetation on the site requires minimal maintenance and should survive with natural precipitation. Areas of dead or dying vegetation should be noted during inspection and re-vegetated using the specified seed mixture and fertilizer. Any areas that are in need of repair due to erosion or other damage should be seeded and fertilized immediately following repair work. This will require that topsoil, seed, fertilizer, etc. be readily available.

In the spring of each growing season qualified personnel may retained to be evaluate the vegetative cover and topsoil. Fertilizer selection and application rates will be applied to the cover as required to maintain a healthy vegetative cover.

Maintenance of the vegetated soil cover includes filling and compaction of rodent burros, holes, settled areas, depressions, cracked or eroded areas. The above will be filled by the appropriate imported fill material and will be compacted to original specifications. Any depressions noted where standing water accumulates should be repaired and maintained at the design grade.

No mowing of the grass cover is anticipated. If mowing is necessary, the equipment should be equipped with non-aggressive tire treads to prevent any tracking of the cover topsoil. Depending on the type of unwanted plant growth, approved herbicides may be used for plant control. These activities should be performed under the direction of qualified personnel.

7.1.2.3.3 Soil Cover Settlement

Settlement monitoring will be conducted on a visual basis during scheduled inspections by the designated representative. Areas with minimal settlement will be filled with topsoil and regraded. Areas with extensive settlement will require monitoring and investigation for failure in the cap system.

7.1.2.3.4 Gravel Access Road and Parking Area

Inspection of the parking area will be conducted quarterly on a visual basis looking for potholes and/or any signs suggesting settlement. Areas with minimal settlement will be filled accordingly.

7.1.2.3.5 Land Use Activities

On an annual basis, an assessment of the land use activities occurring at the Site will be performed to ensure that such activities do not cause an intrusion into the cover materials. The assessment will consist of a visual inspection conducted by a designated representative.

7.1.2.3.6 Perimeter Site Fencing and Posted Warning Signs

Inspection of perimeter fencing and posted signs will be conducted quarterly by a designated representative. Evidence of vandalism or unauthorized access should be reported to the New Hampshire State Police, EPA, NHDES, and the Town of Merrimack Police Department. The posted signs warning will be maintained so that they remain in place and are easily readable. Damage to the fence, gates, and/or signs will be repaired. Gate locks will be inspected to ensure they are working properly and replaced if necessary.

7.1.2.3.7 Slope Stability

Slope stability monitoring will be conducted on a visual basis during scheduled inspections by the designated representative. Areas with minimal erosion will be filled with topsoil and regraded. Areas with extensive erosion will require monitoring and investigation for failure of slope stability.

7.1.2.4 Operations and Maintenance Activities/Schedule

Maintenance of the cover components and site features should be completed in accordance with the Maintenance Schedule presented in Table 7-1 in addition to items documented from semi-annual inspections.

Table 7-1
Operations and Maintenance Activities/Schedule

Post-Closure Tasks		Frequency of Occurrence	
		First 2 Years	After 2 Years
1.	Maintaining the vegetative growth and soil cover through annual reseeding, fertilizing, and mowing.	Quarterly	Annual
2.	Repairing the soil cover if settlement occurs	Quarterly	Annual
3.	Maintaining and repairing parking areas.	Quarterly	Annual
4.	Assessing that the land use activities do not cause intrusion into the cover materials.	Quarterly	Annual
5.	Maintain the perimeter site fencing and posting of signs to warn against digging activities.	Quarterly	Annual
6.	Miscellaneous Maintenance and Inspection.	Quarterly	Annual

7.1.3 Annual Inspections and Maintenance

Annual inspections will be conducted on each cover component and site features after the first two years. Specific items are detailed in Sections 7.1.1 and 7.1.2 for the vegetated cover system surface, soil cover settlement, parking areas, site fencing and posted signs.

7.2 Potential Problems of Concerns with O&M Activities

The potential operating problems that may be encountered at the NHPC have been summarized below in Table 7-2. The table addresses the potential problems, concerns, and necessary actions.

Table 7-2
Potential Operational Problems and Response Actions

Potential Problem	Concern	Action
GENERAL		
Potential Problem	**Concern**	**Action**
Locks Secure	Tampering, site security	Replace and secure locks as necessary. Make sure locks are operational.
Perimeter Fence	Forced entry or seasonal damage.	Repair or replace as needed
Warning Signs	Tampering or theft.	Replace any damaged or stolen signs
VEGETATED SOIL COVER		
Potential Problem	**Concern**	**Action**
Erosion	Wash out of grass, topsoil, stone or sand.	Take immediate action to prevent further erosion and exposure of cover components. Recover washed out material to restore area. Backfill with additional soil to original grade. Reseed with grasses to existing conditions. Use erosion control matting on slopes.
Bare Areas	Potential for erosion	Loosen and till topsoil. Reseed and mulch as necessary.
Puddles	Settlement of original cover. Standing water.	Till topsoil and grade, adding additional topsoil if necessary and checking final elevation to ensure adequate drainage. Reseed and mulch. If ponding is minor, grading of topsoil should be sufficient. Significant settlement will require monitoring and investigation.
Dead/Dying Grass	As with bare areas, potential for erosion	Till topsoil and reseed. Cover with erosion control mat or mulch.
Animal Holes/ Burrows	Integrity of capping system may be jeopardized. Safety hazard.	Contact local animal control department about trapping/relocation of persistent rodent. Seal all holes with clean soil fill. Replace topsoil, seed and mulch.
PARKING AREA AND SOIL COVER SETTLEMENT		
Potential Problems	**Concern**	**Action**
Potholes	Suggests settlement, Safety hazard.	Backfill and compact to grade.
Obstructions	Suggests settlement, Safety hazard.	Remove obstructions as soon as possible. Place in secure area pending off-site removal.
Animal Holes/Burrows	Potential for erosion initiation.	Contact local animal control department about trapping/relocation of persistent rodent. Seal all holes with clean soil fill. Replace topsoil, seed and mulch.
Soil on road surface from adjacent wash outs areas.	Potential for washout and impassable condition.	Clear off all soil and repair soil cover. As needed, install berms to prevent further washouts.

8

8.0 SUMMARY OF PROJECT COSTS

This section provides a summary of the source control remedy project costs.

8.1 Remediation Costs

Table 8-1 provides a summary of costs for the source control (soil) remediation activities beginning with the Remedial Investigation/Feasibility Study (RI/FS) and concluding with completion of site restoration. Additional future costs that will be incurred include regular O&M. Costs associated with the management of migration (groundwater) remedy are reported in the Interim Management of Migration RA Report.

Cost Elements for the Remedial Action at NHPC Site
(dollars in thousands)

General Activity Areas	Second Level Cost Element	Cost Items	Costs ($)	Subtotal ($)
Preliminary / Preconstruction Activities	RI/FS	RI	1,521	1,656
		FS	135	
	Remedial Design	Project Planning and Support	81	368
		Community Relations	4	
		Data Acquisitions	44	
		Analytical Support and Data Validation	3	
		Data Evaluation	10	
		Treatability Study/ Pilot Testing	9	
		Preliminary Design	47	
		Pre-Final/Final Design	156	
		Work Assignment Closeout	1	
Remediation Activities	NTCRA	NTCRA Operations Building Demolition	376	376
	Phase I Remedial Action	Monitoring Well Decommissioning/ Supplemental Soil Investigation	68	747
		Geotechnical Laboratory Services	2	
		Analytical Laboratory Services	6	
		Surveying Services	13	
		Electrician Services	2	
		Site Preparation, Clearing, and Demolition of the Solidified Materials Storage Cell	656	
	Phase II Remedial Action	Mobilization, contaminated soils excavation, soil treatment (chemical fixation), soil backfilling, soil cover installation, and site restoration	8,765	8,785
		Analytical Laboratory Services	20	
	Engineering Services	Design services, RA oversight, additional site investigation oversight, O&M manual preparation , and RA Closeout Report preparation	1,417	1,417
		Total Remedial Action Costs		**$13,336 K**

Note: Costs as of August 24, 2007.

An analysis of remediation costs versus the RA costs estimated in the ROD is provided in the supplemental RA Report data submittal.

9

9.0 OBSERVATIONS AND LESSONS LEARNED

This section provides a discussion of observations and lessons learned in three areas during the implementation of the source control (soil) remedial action activities at the Site.

9.1 Geotechnical Information

Prior to the commencement of remedial activities, a geotechnical investigation of the existing soil characteristics would have been beneficial in determining the level of effort required in compaction of treated soil that was encountered during the backfilling process. Limited geotechnical data were available regarding *in situ* soils at the NHPC Site.

During excavation, soil treatment, and backfilling operations, lower than anticipated productivity was experienced due to the high organic content and cohesive soils (i.e. silts) encountered in the existing on-site soils. Excavated soils were frequently saturated during the excavation and treatment processes as a result of the high groundwater conditions experienced during the remedial action. The saturated non-granular soils were difficult to process as they tended to clump forming blockages on the treatment system power screen resulting in work stoppages to clear the screen. In addition, treated soils backfill had to achieve compaction density requirements. Due to the wide variety of soil types encountered within each soil treatment batch, it was difficult to obtain representative samples for grain size analysis and the Modified Proctor laboratory tests necessary for compaction testing of soil backfill with a nuclear density gage.

The problem determining field maximum dry densities for backfill compaction control was resolved by utilizing the test strip method. The test strip method required six-dead roll passes over a 12-inch test lift of the treated soil to be backfilled and field tests the achieved compaction. The average value of four tests was utilized to establish a new maximum compaction value. The acceptable backfill compaction rate was set at 97 percent of the maximum test strip density. The nuclear density gage was recalibrated based on the new compaction test. A test strip was constructed whenever backfill material changed significantly or every few days in order to maintain an accurate maximum dry field density. After the introduction of the test strip method, compaction requirements were achieved for the majority of compaction tests.

9.2 Groundwater Levels

An accurate groundwater level study to determine the Site water table during the remedial action would have been valuable in planning and executing the soil excavation and dewatering operations as the ROD required excavation of contaminated soils down to the water table. However, during excavation of Lagoon 1, the groundwater levels in the Lagoon 1 area were approximately 3 to 4 feet higher than the target excavation elevation of 102 feet, due mainly to the record precipitation received in the past year. In addition, the water level in Lagoon 2 at elevation 110.5 feet was causing a higher groundwater level in the lagoon system.

Based on the high groundwater level encountered the soil excavation target elevations were raised; however, excavation below the water table occurred in all areas in order to remove the most contaminated soil feasible. This resulted in reduced excavation and treatment production rates of contaminated soil due to the saturated soil conditions. In addition, to achieve this excavation depth, a significant dewatering effort amount that was not planned was necessary. This resulted in a significant increase in the quantity of groundwater and discharge to the Merrimack wastewater system as discussed in Section 3.3.5. It should be noted that a contributory factor to the high groundwater levels was the May 2006 flooding which resulted in a major floodwater removal operation as discussed in Section 3.3.6.

9.3 Soil Treatment System

During the NHPC Superfund Site Phase II, the remedial action excavator soil treatment method was more productive than the soil treatment system. The treatment system used to mix the chemical reagent and contaminated soil consisted of a powered screen, belt conveyors, a hopper, a chemical feed system, a pugmill, and belt conveyors. During winter operation, equipment failures and mechanical difficulties resulted in soil treatment plant shutdowns and reduced daily production rates.

In early January 2006, SES requested approval to change the soil/reagent mixing process from the pugmill system to a method that employed excavators and front-end loaders. SES's proposal was based on considerable experience using this method for many of their other chemical fixation projects. In addition, this method had been used previously on site to process a treatment batch due to the pugmill feeder belt breakage and this batch passed the SPLP treatment criteria. Based on results for a 2-week trial period, TtNUS approved the use of the excavator soil mixing method for the rest of the winter operation.

When operations resumed after the May 2006 flood recovery, SES recommenced soil treatment using excavator mixing because of a concern that the reagent that sat in the silos during the flood recovery period would cake causing uneven reagent flow and ineffective soil treatment using the pugmill system. Another concern was that the excavated soils saturated silty soil would not pass the screening process resulting in ineffective soil treatment using the pugmill system. With the approval of TtNUS and EPA, SES continued soil treatment using excavator mixing. Due to the high percentage of saturated silty soil encountered during the remainder of the excavation and treatment process, excavator mixing was utilized for the remainder of soil treatment activities on site.

Comparison of the daily production rates and treated soil sample results show that treatment using the excavator mixing was as effective as the soil treatment system method and that the daily production rates were in general higher using the excavator mixing. In addition, less down time due to mechanical failure was experienced with excavator mixing, because if an excavator/front-end loader experienced mechanical problems, switch-out was fairly easy with another piece of on-site equipment.

10

10.0 OPERABLE UNIT CONTACT INFORMATION

Contact information for parties involved with implementing the source NHPC Site source control remedial action is provided as follows:

EPA Remedial Project Manager:

Address:	US EPA – Region 1 Office of Site Remediation & Restoration 1 Congress Street, Suite 1000 Boston, MA 02114-2023
Name:	James Chow
Phone:	(617) 918-1394

State Remedial Project Manager:

Address:	New Hampshire Department of Environmental Services Waste Management Division Hazardous Waste Remediation Bureau 29 Hazen Drive Concord, NH 03302-0095
Name:	Tom Andrews
Phone:	(603) 271-2910

Design Engineer and Construction Oversight for EPA:

Company:	Tetra Tech NUS, Inc. / Tetra Tech EC, Inc.
Address:	55 Jonspin Road Wilmington, MA 01887
Contact:	James Forrelli
Title:	Project Manager
Phone:	(978) 474-8412

Design Engineer for Tetra Tech NUS, Inc. /Tetra Tech EC, Inc.:

Company:	Nobis Engineering, Inc.
Address:	18 Chenell Drive Concord, NH 03301
Contact:	J. Chris Nadeau
Title:	Project Manager
Phone:	(603) 224-4182

Phase I Remedial Subcontractor for Tetra Tech NUS, Inc:

Company:	ECI Northeast, LLC.
Address:	3 Howe Drive, Suite 1
	Amherst, NH 03031
Contact:	Tim Cullinan
Title:	Regional Manager
Phone:	(603) 821-7050

Phase II Remedial Subcontractor for Tetra Tech NUS, Inc / Tetra Tech EC, Inc.:

Company:	Sevenson Environmental Services, Inc.
Address:	8270 Whitcomb Street
	Merrillville, IN 46410
Contact:	Steven Sharp
Title:	Project Manager
Phone:	(219) 756-4686

11

11.0 REFERENCES

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FIGURES

FIGURES

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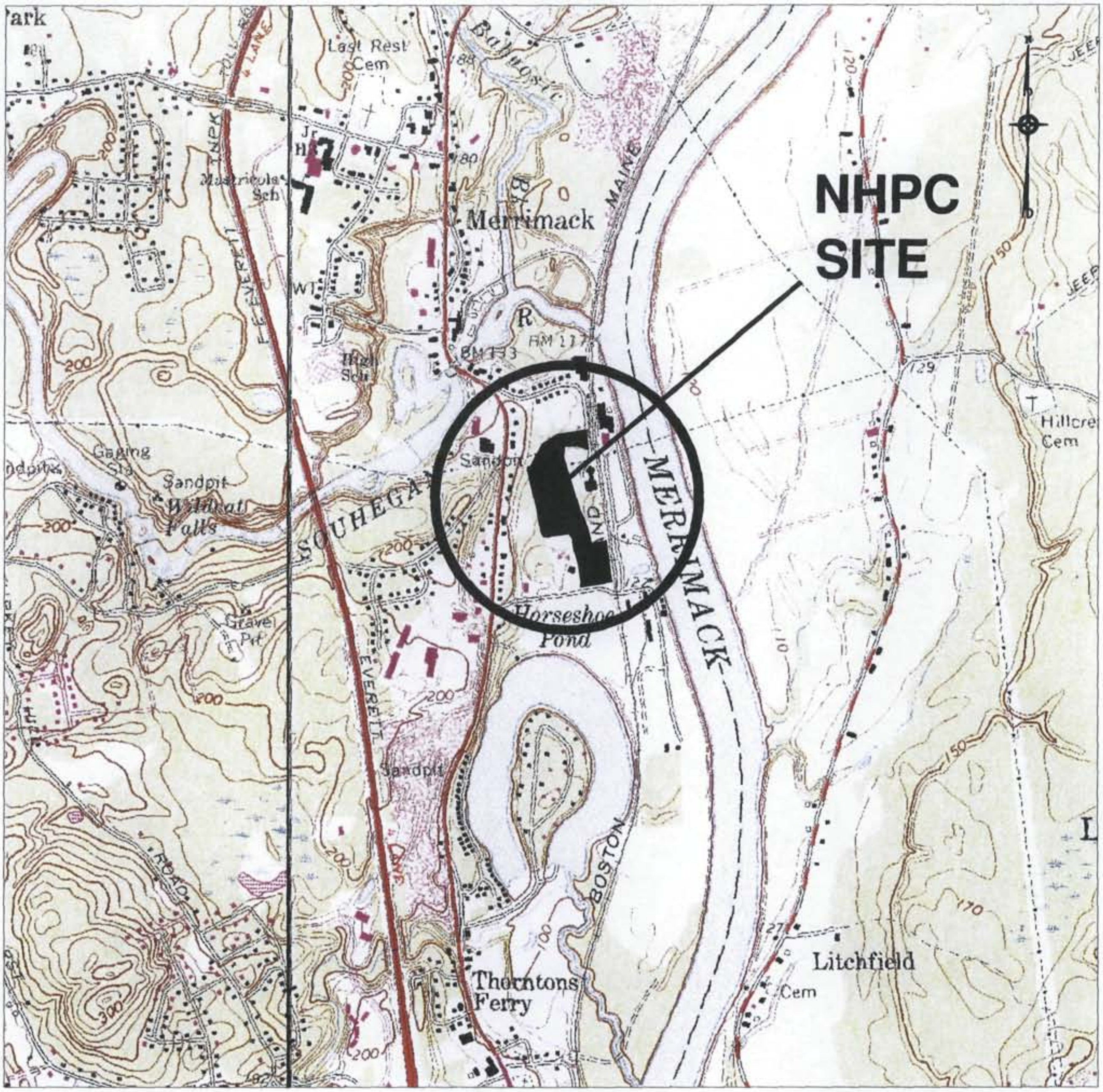


BASE MAP IS A PORTION OF THE FOLLOWING 7.5 X 15 MINUTE U.S.G.S. QUADRANGLE:
NASHUA, NEW HAMPSHIRE, 1968, PHOTOREVISED 1985 AND
SOUTH MERRIMACK, NEW HAMPSHIRE, 1968, PHOTOREVISED 1985

GRAPHIC SCALE

0 0.5 MILE 1 MILE

QUADRANGLE LOCATION

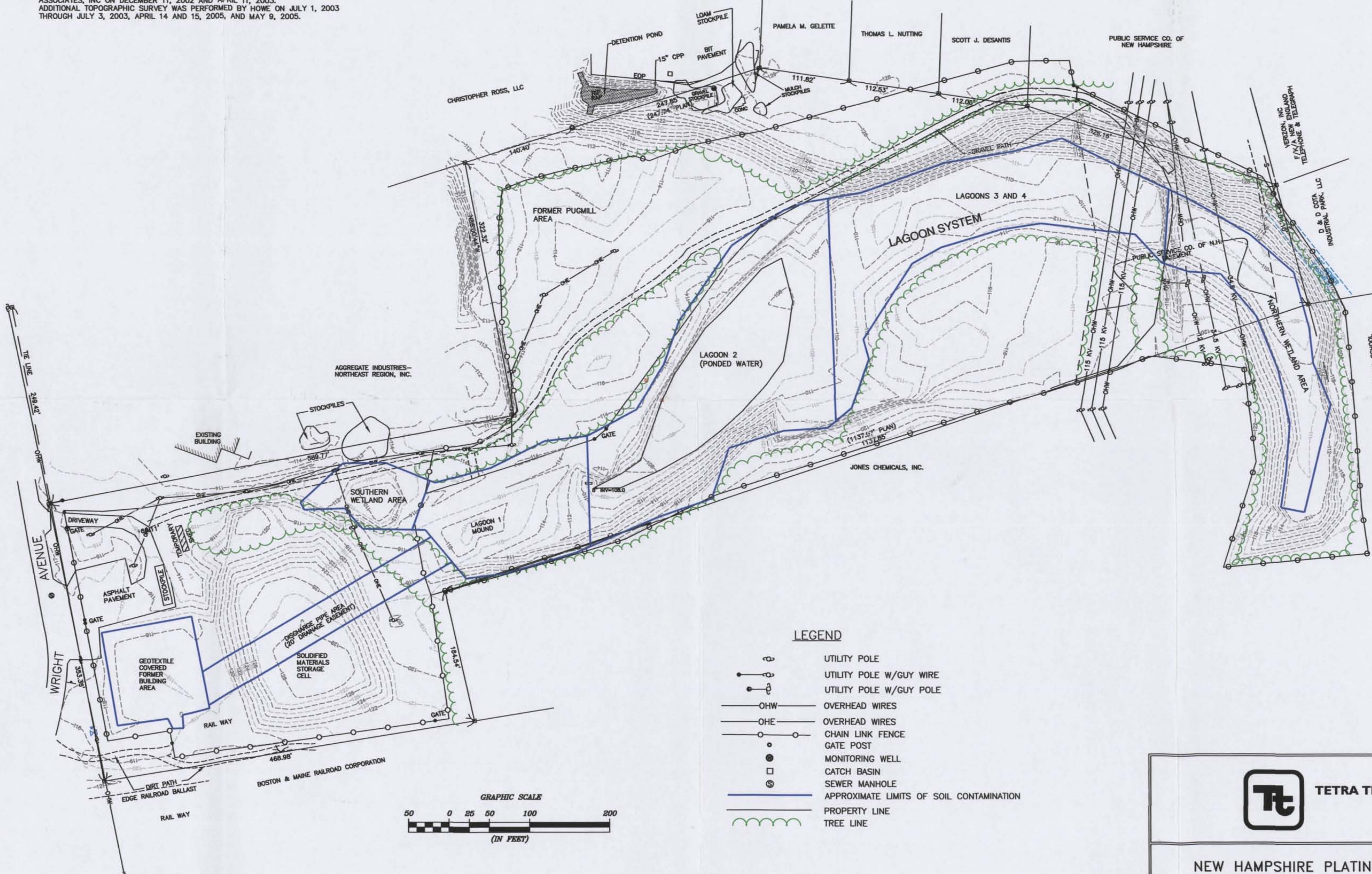
TETRA TECH EC, INC.

SITE LOCATION MAP
NEW HAMPSHIRE PLATING CO. SITE
MERRIMACK, NEW HAMPSHIRE

SCALE AS NOTED	
FILE \106-1945\2158.1000.0400\USGS.DWG	
REV 0	DATE 08/15/07
FIGURE NUMBER 1-1	

GENERAL NOTES

1. BASE PLAN OBTAINED FROM A TOPOGRAPHIC PLAN FOR WRIGHT AVENUE, MERRIMACK, NEW HAMPSHIRE, PREPARED FOR TETRA TECH NUS, INC., BY HOWE SURVEYING ASSOCIATES, INC. DATED JULY 11, 2001.
2. LOCATION OF TREELINE WAS OBTAINED FROM USGS AERIAL PHOTOGRAPH DATED 4/11/98. LOCATIONS ARE APPROXIMATE ONLY.
3. SURVEY OF PROPERTY BOUNDARY PERFORMED BY HOWE SURVEYING ASSOCIATES, INC ON DECEMBER 11, 2002 AND APRIL 11, 2003. ADDITIONAL TOPOGRAPHIC SURVEY WAS PERFORMED BY HOWE ON JULY 1, 2003 THROUGH JULY 3, 2003, APRIL 14 AND 15, 2005, AND MAY 9, 2005.



LEGEND

- UTILITY POLE
- UTILITY POLE W/GUY WIRE
- UTILITY POLE W/GUY POLE
- OHW — OVERHEAD WIRES
- OHE — OVERHEAD WIRES
- CHAIN LINK FENCE
- GATE POST
- MONITORING WELL
- CATCH BASIN
- SEWER MANHOLE
- APPROXIMATE LIMITS OF SOIL CONTAMINATION
- PROPERTY LINE
- TREE LINE

TETRA TECH EC, INC.

NEW HAMPSHIRE PLATING COMPANY SITE
PRIOR TO REMEDIAL ACTION

U.S. ENVIRONMENTAL PROTECTION AGENCY

MERRIMACK, NEW HAMPSHIRE

FILE	SCALE
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FIGURE NUMBER 1-2	REV 0 — DATE 08/15/07

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GENERAL NOTES

1. BASE PLAN OBTAINED FROM A TOPOGRAPHIC PLAN FOR WRIGHT AVENUE, MERRIMACK, NEW HAMPSHIRE, PREPARED FOR TETRA TECH NUS, INC., BY HOWE SURVEYING ASSOCIATES, INC. DATED JULY 11, 2001.
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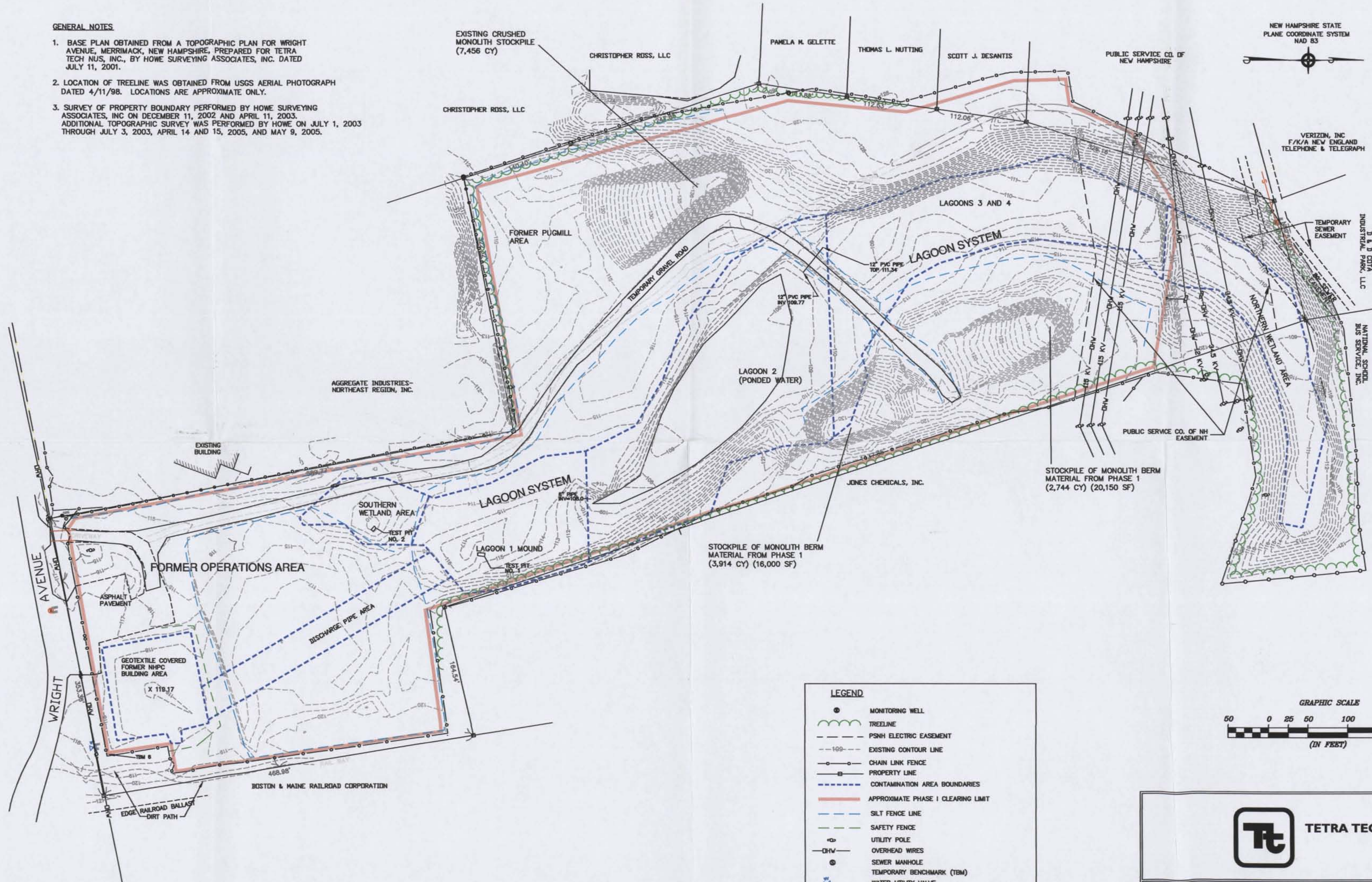

LEGEND

- MONITORING WELL
- TREELINE
- PSNH ELECTRIC EASEMENT
- EXISTING CONTOUR LINE
- CHAIN LINK FENCE
- PROPERTY LINE
- CONTAMINATION AREA BOUNDARIES
- APPROXIMATE PHASE I CLEARING LIMIT
- SILT FENCE LINE
- SAFETY FENCE
- UTILITY POLE
- OHW — OVERHEAD WIRES
- SEWER MANHOLE
- TEMPORARY BENCHMARK (TBM)
- WATER UTILITY VALVE

TETRA TECH EC, INC.

NEW HAMPSHIRE PLATING COMPANY SITE
AFTER PHASE I RA

U.S. ENVIRONMENTAL PROTECTION AGENCY

MERRIMACK, NEW HAMPSHIRE

FILE	SCALE
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FIGURE NUMBER 3-1	REV 0 / DATE 08/15/07

ACAD: \106-1945\2158.1000.0400\SITE_POST_PHASE1.DWG 08/15/07 DWM

NOTE: MONITORING WELLS NOT SHOWN

NO.	REVISIONS	BY	DATE	CHK.	DATE
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SEAL

DRAWN BY DWM DATE 08/15/07
CHECKED BY JRF DATE 08/15/07
APPROVED BY DATE
SCALE AS NOTED

Tetra Tech EC, Inc.

NEW HAMPSHIRE PLATING COMPANY SITE
AFTER PHASE II RA
U.S. ENVIRONMENTAL PROTECTION AGENCY
MERRIMACK, NEW HAMPSHIRE

CONTRACT NO. 00588
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DRAWING NO. 3-2
REV. 0

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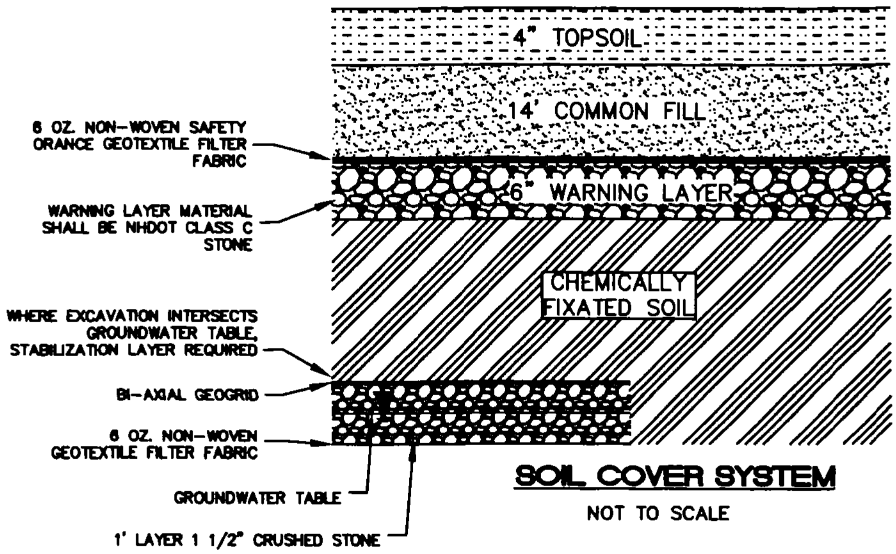
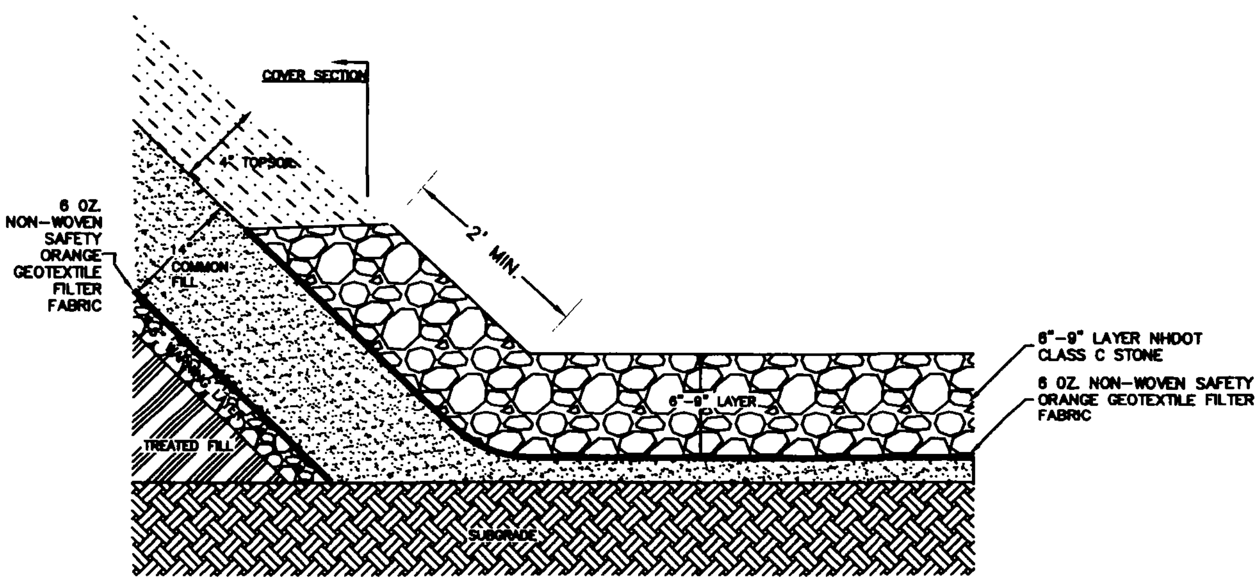


SOIL COVER SYSTEM

NOT TO SCALE



FLOOD STORAGE COVER SYSTEM

NOT TO SCALE

TETRA TECH EC, INC.	COVER SYSTEM CROSS-SECTIONS NEW HAMPSHIRE PLATING CO. SITE MERRIMACK, NEW HAMPSHIRE	SCALE AS NOTED FILE REV 0 DATE 09/19/07 FIGURE NUMBER 3-3

APPENDIX A

APPENDIX A

EXCAVATION CONFIRMATION SOIL SAMPLE RESULTS EVALUATIONS

APPENDIX A-1

LAGOON 1 / SOUTH WETLAND AREA
EXCAVATION CONFIRMATION SOIL SAMPLE RESULTS EVALUATION

LAGOON 1 AREA AND SOUTHERN WETLAND AREA EXCAVATION CONFIRMATION SOIL SAMPLE RESULTS EVALUATION PHASE II REMEDIAL ACTION (SOIL REMEDIATION) NEW HAMPSHIRE PLATING SITE, MERRIMACK, NEW HAMPSHIRE AUGUST 18, 2006

An evaluation of the Lagoon 1 Area and the Southern Wetland Area (SWA) excavation confirmation soil sample results for attainment of the cleanup level for the New Hampshire Plating Company Site (NHPC Site) soil remediation is presented below.

Cleanup Level

Cleanup levels for NHPC Site soils were established to protect the aquifer from soil leachate. The Excel-Crystal Ball Transport (ECTran) model was used to estimate residual soil levels that are not expected to impair future groundwater quality. Soil clean-up levels for cadmium were developed for each major source areas to account for variation in flow paths, hydrogeologic conditions and contaminant concentrations. Lagoon 1 Area and the SWA were modeled as one source area resulting in a cadmium soil cleanup level of 6.42 mg/kg.

The soil cadmium cleanup level is used to identify the contaminated soil areas of the NHPC Site that need to be excavated and treated, using the chemical fixation process, to prevent leaching of metals from treated soils when backfilled on-site.

Lagoon 1 Area/SWA Excavation Confirmation Sampling

As of the end of April 2006 the contaminated soils within the Lagoon 1 Area and the SWA have been excavated to an elevation ranging from 104 feet in Lagoon 1 to 105.5 feet in the SWA. The extent of the excavation encompasses the contaminated areas as identified by the remedial design drawings. The SWA was excavated to the actual water table while the Lagoon 1 Area was excavated to a depth 1 to 1.5 feet below the actual water table. Soil excavation confirmation samples for cadmium analysis were collected from the excavation sidewalls. The initial approach to implementing the cleanup level for the site was to excavate the sidewall soil such that the residual soil cadmium concentration does not exceed the cleanup level. Therefore, when excavation sidewall soil cadmium levels exceed the soil cleanup level, additional soil was excavated and the sidewall sampled again. Some locations have been re-excavated three times.

The soil excavation confirmation samples are composite soil samples collected from the sidewall at intervals of 25 feet on center. At each sample location, the composite sample was prepared by obtaining soil aliquots at a 2-foot interval along a vertical transect from the bottom to top of excavation. Typically the length of the vertical transect ranges from 6 to 14 feet, therefore the number of soil aliquots typically obtained from each sample location ranges from four to eight.

A total of 34 sidewall locations were sampled; 19 from the Lagoon 1 Area and 15 from the SWA as shown in Drawing 1. The residual cadmium concentrations in the excavation sidewall soils based on samples collected as of May 4, 2006 are provided in Table 1 (attached). The mean cadmium soil concentration for the 34 sample locations is 2.99 mg/kg; the results range from a less-than–detection-limit value (non detect) to a maximum value being 21 mg/kg. Results for 2 locations exceed the 6.42 mg/kg cadmium soil concentration cleanup level. Non detect results were recorded for 7 locations (21 percent of results).

Statistical Analysis

To determine whether the lateral extent of the Lagoon 1 Area/SWA excavation has attained the required clean up level, a statistical analysis of the sidewall soil sample results was performed. The approach is based on the assumption that most of the soil exceeding the cleanup level, including the soil with the highest cadmium concentrations, has been excavated such that the upper confidence limit (UCL) of the mean cadmium concentration in the remaining soil is at or below the cleanup level. The 95 percent UCL equals or exceeds the true mean 95 percent of the time. The 95 percent UCL of the arithmetic mean accounts for the uncertainty in estimating the true mean of an environmental data set and provides reasonable confidence that the true mean will not be underestimated.

Statistical methods for determining whether the mean concentration of the site is less than a cleanup standard presented in Methods for Evaluating the Attainment of Cleanup Standards (EPA 230/02-89-042) Chapter 6 assume that the contaminant concentrations follow a normal distribution, and calculate an upper confidence limit (UCL) based on the Students-t statistic. The Lagoon 1 Area/SWA excavation sidewall soil cadmium concentration data set was analyzed using a TtNUS-modified version of EPA's ProUCL (Version 3.00.02, August 2004) software. This software calculates the 95 percent UCLs using 15 different computation methods, 5 parametric and 10 non-parametric. ProUCL then suggests which UCL is most appropriate for the data set.

Using the mean as the basis of comparison to the cleanup level involved the following procedures for handling certain data such as duplicate results, replicate results, less-than–detection-limit results, and outliers.

Replicate and duplicate sample results were averaged.

Values reported as being less less-than–detection-limit (non detects) were included in the analysis at the reporting detection limit.

All data not known to be in error was considered valid. No outliers were identified. The maximum soil cadmium concentration value is 23 mg/kg from a Lagoon 1 eastern sidewall sample location 13 (L1-13). This location is significantly beyond the limit of known site activity; however, a replicate sample from this location yielded a similar value (19 mg/kg) verifying the initial result. Follow-up sampling of this location was performed and consisted of collecting four grab samples that yielded non detect results for cadmium. While the averaged composite sample result skews the data and appears to be an outlier, this value is not known to be in error and was thus considered valid for the purpose of the analysis.

Results

The Lagoon 1 Area/SWA excavation soil cadmium data statistical analysis results are summarized below.

Variable	cadmium (mg/kg)
Number of Valid Samples	34
Number of Unique Samples	30
Minimum	0.094
Maximum	21
Mean	2.99
Median	2.4
Standard Deviation	3.69
Variance	13.6
Coefficient of Variation	1.23
Skewness	3.70
Approximate Gamma UCL	4.09

According to ProUCL, the Lagoon 1 Area/SWA excavation confirmation cadmium soil data does not follow a normal distribution. ProUCL determined, based on goodness of fit tests, that the data follows a gamma distribution and therefore the approximate gamma UCL is, therefore, a more appropriate UCL to use for evaluating the attainment of the cleanup standard. The calculated mean of the Lagoon 1 Area/SWA excavation confirmation cadmium soil data is 2.99 mg/kg and the 95 percent gamma UCL is 4.09 mg/kg. It should be noted that the approximate gamma UCL (4.09) calculated by ProUCL is slightly higher than the Students-t UCL (4.06).

According to the ProUCL Version 3.0 User Guide "Many positively skewed data sets follow a lognormal as well as a gamma distribution. Gamma distribution can be used to model positively skewed environmental data sets. It is observed that the use of a gamma distribution results in reliable and stable 95% UCL values. It is therefore, desirable to test if an environmental data set follows a gamma distribution. If a skewed data set does follow a gamma model, then a 95% UCL of the population mean should be computed using a gamma distribution."

Conclusion

The calculated mean of cadmium analytical results for 34 Lagoon 1 Area/SWA excavation sidewall confirmation soil sample locations is 2.99 mg/kg, which indicates that the 6.42 mg/kg cleanup level has been attained. To account for the uncertainty in estimating the true mean of the data set the 95 percent UCL for this data set was calculated using ProUCL, an EPA statistical software program. ProUCL found that the data set does not follow a normal distribution and determined that the approximate gamma 95 percent UCL of 4.09 mg/kg provides the most appropriate UCL. Based on this analysis, it can be stated that the true mean of the Lagoon 1 Area/SWA excavation sidewall soil cadmium concentration is probably equal to or less than 4.09 mg/kg. This value is significantly less than the cleanup level of 6.42 mg/kg. Therefore, the statistical analysis result indicates, with reasonable assurance, that the cleanup level for the NHPC Site Lagoon 1 Area/SWA excavation sidewall is attained.

Reference

US Environmental protection Agency, 1989. Methods for Evaluating the Attainment of Cleanup Standards (EPA 230/02-89-042). February 1989.

US Environmental Protection Agency, 2002. Estimation of the Exposure Point Concentration Term Using a Gamma Distribution. Technology Support Center Issue. Office of Solid Waste and Emergency Response. EPA 600/R-02/084. October.

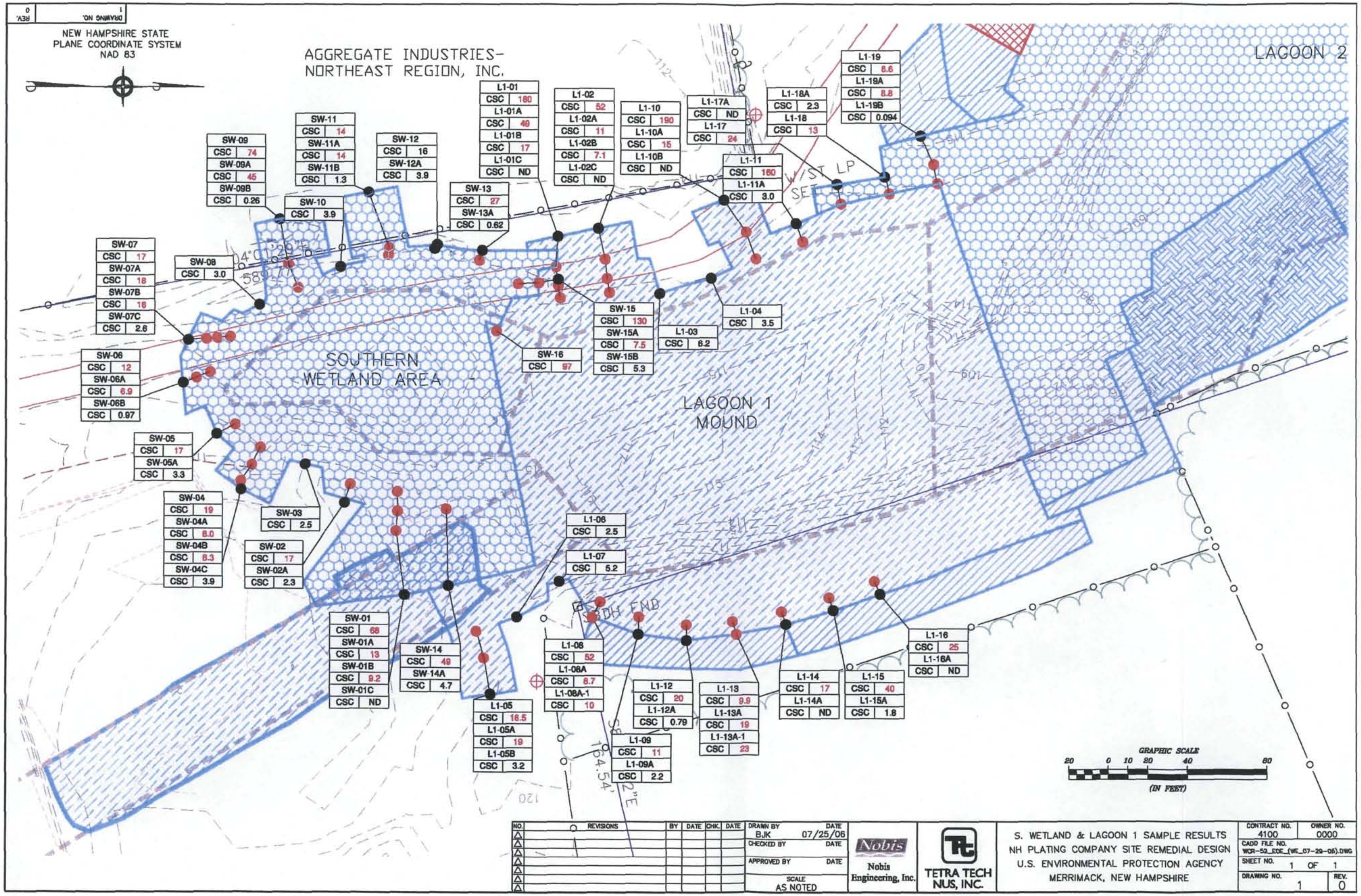
ProUCL Version 3.0 User Guide, April 2004. Authors: Anita Singh, Lockheed Martin Environmental Services; Ashok K. Singh, University of Nevada; and Robert W. Maichle, Lockheed Martin Environmental Services.

Table 1
Lagoon 1 Area and Southern Wetland Area (SWA) Soil Excavation Sample Cadmium Results
Phase II Remedial Action (Soil Remediation), New Hampshire Plating Site, Merrimack, NH

Excavation Area	Sample Location ID	Cadmium (mg/kg)	Comments
Lagoon 1	NHP-L1-01C	0.48U	
	NHP-L1-02C	0.52U	
	NHP-L1-03	6.2	
	NHP-L1-04	3.5	
	NHP-L1-05B	3.2	
	NHP-L1-06	2.5	
	NHP-L1-07	5.2	
	NHP-L1-08A	8.7	
	NHP-L1-08A-1	10	NHP-L1-08A replicate
	NHP-L1-08A-2	2.2	NHP-L1-08A replicate
	NHP-L1-09A	2.2	
	NHP-L1-10B	0.50U	
	NHP-L1-DUP05	0.50U	NHP-L1-10B duplicate
	NHP-L1-11A	3	
	NHP-L1-12A	0.79	
	NHP-L1-DUP04	1.1	NHP-L1-12A duplicate
	NHP-L1-13A	19	
	NHP-L1-13A-1	23	NHP-L1-13A replicate
	NHP-L1-14A	0.46U	
	NHP-L1-15A	1.8	
	NHP-L1-16A	0.47U	
	NHP-L1-17A	0.51U	
	NHP-L1-18A	2.3	
	NHP-L1-19B	0.094J	
Southern Wetland Area	NHP-SW-01C	ND	
	NHP-SW-02A	2.3	
	NHP-SW-03	2.5	
	NHP-SW-04C	3.9	
	NHP-SW-05A	3.3	
	NHP-SW-06B	0.97	
	NHP-SW-07C	2.6	
	NHP-SW-DUP03	2.6	NHP-SW-07C duplicate
	NHP-SW-08	3.0	
	NHP-SW-09B	0.26J	
	NHP-SW-10	3.9	
	NHP-SW-DUP02	5.6	NHP-SW-10 duplicate
	NHP-SW-11B	1.3	
	NHP-SW-12A	3.9	
	NHP-SW-13A	0.62	
	NHP-SW-14A	4.7	
	NHP-SW-15B	5.3	

Laboratory: Alpha Analytical
Notes:
Results exceeding cleanup level indicated by black background.
Alpha character following location number designates re-excavation sample; "A" designates first re-excavation, "B" designates second re-excavation and "C" designates third re-excavation.
Numerical character following location number designates replicate sample; "1" designates first replicate sample and '2" designates second replicate sample.

J	estimated positive result above MDL but below RDL
L1	Lagoon 1 Area
MDL	method detection limit
µg/L	micrograms per liter
NA	not applicable
U	not detected at or above the MDL and presented at the level of the laboratory RDL
RDL	reporting detection limit
SW	Southern Wetland Area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PLANE COORDINATE SYSTEM
NAD 83
AGGREGATE INDUSTRIES-
NORTHEAST REGION, INC.
LAGOON 2
SOUTHERN
WETLAND AREA
LAGOON 1
MOUND
SW-09 CSC 74 SW-09A CSC 45 SW-09B CSC 0.26
SW-11 CSC 14 SW-11A CSC 14 SW-11B CSC 1.3
SW-12 CSC 16 SW-12A CSC 3.9
SW-10 CSC 3.9
SW-13 CSC 27 SW-13A CSC 0.62
L1-01 CSC 180 L1-01A CSC 49 L1-01B CSC 17 L1-01C CSC ND
L1-02 CSC 52 L1-02A CSC 11 L1-02B CSC 7.1 L1-02C CSC ND
L1-10 CSC 190 L1-10A CSC 15 L1-10B CSC ND
L1-17A CSC ND L1-17 CSC 24
L1-18A CSC 2.3 L1-18 CSC 13
L1-19 CSC 8.6 L1-19A CSC 8.8 L1-19B CSC 0.094
L1-11 CSC 160 L1-11A CSC 3.0
SW-07 CSC 17 SW-07A CSC 18 SW-07B CSC 16 SW-07C CSC 2.6
SW-08 CSC 3.0
SW-15 CSC 130 SW-15A CSC 7.5 SW-15B CSC 5.3
L1-03 CSC 6.2
L1-04 CSC 3.5
SW-16 CSC 97
SW-06 CSC 12 SW-06A CSC 6.9 SW-06B CSC 0.97
SW-05 CSC 17 SW-05A CSC 3.3
SW-04 CSC 19 SW-04A CSC 8.0 SW-04B CSC 8.3 SW-04C CSC 3.9
SW-03 CSC 2.5
SW-02 CSC 17 SW-02A CSC 2.3
L1-06 CSC 2.5
L1-07 CSC 5.2
SW-01 CSC 68 SW-01A CSC 13 SW-01B CSC 9.2 SW-01C CSC ND
SW-14 CSC 49 SW-14A CSC 4.7
L1-08 CSC 52 L1-08A CSC 8.7 L1-08A-1 CSC 10
L1-05 CSC 16.5 L1-05A CSC 19 L1-05B CSC 3.2
L1-12 CSC 20 L1-12A CSC 0.79
L1-13 CSC 9.9 L1-13A CSC 19 L1-13A-1 CSC 23
L1-09 CSC 11 L1-09A CSC 2.2
L1-14 CSC 17 L1-14A CSC ND
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L1-16 CSC 25 L1-16A CSC ND
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S. WETLAND & LAGOON 1 SAMPLE RESULTS
NH PLATING COMPANY SITE REMEDIAL DESIGN
U.S. ENVIRONMENTAL PROTECTION AGENCY
MERRIMACK, NEW HAMPSHIRE
CONTRACT NO. 4100
OWNER NO. 0000
SHEET NO. 1 OF 1
DRAWING NO. 1
REV. 0

APPENDIX A-2

LAGOON 2

EXCAVATION CONFIRMATION SOIL SAMPLE RESULTS EVALUATION

LAGOON 2 AREA
EXCAVATION CONFIRMATION SOIL SAMPLE RESULTS EVALUATION
PHASE II REMEDIAL ACTION (SOIL REMEDIATION)
NEW HAMPSHIRE PLATING SITE, MERRIMACK, NEW HAMPSHIRE
AUGUST 24, 2006

An evaluation of the Lagoon 2 Area excavation confirmation soil sample results for attainment of the cleanup level for the New Hampshire Plating Company Site (NHPC Site) soil remediation is presented below.

Cleanup Level

Cleanup levels for NHPC Site soils were established to protect the aquifer from soil leachate. The Excel-Crystal Ball Transport (ECTran) model was used to estimate residual soil levels that are not expected to impair future groundwater quality. Soil clean-up levels for cadmium were developed for each major source areas to account for variation in flow paths, hydrogeologic conditions and contaminant concentrations. Lagoon 2 Area was modeled as one source area resulting in a cadmium soil cleanup level of 2.55 mg/kg.

The soil cadmium cleanup level is used to identify the contaminated soil areas of the NHPC Site that need to be excavated and treated, using the chemical fixation process, to prevent leaching of metals from treated soils when backfilled on-site.

Lagoon 2 Area Excavation Confirmation Sampling

The Lagoon 2 area target excavation elevation was established at evaluation 105 feet (approximate water table elevation), subject to revision by TtNUS depending on the actual water table encountered. During the excavation operations, the presence of a clay layer in Lagoon 2 permitted the actual excavation to an elevation of 105 feet or lower throughout most of the Lagoon 2 Area. Excavated to the top of the clay layer established a dry solid base for backfilling operations with minimal groundwater encountered and no dewatering was necessary. However, in the northwest area of Lagoon 2, the actual water table encountered was higher; therefore the target excavation elevation was revised to 106 feet for that area.

The extent of the excavation encompasses the contaminated areas as identified by the remedial design drawings. Soil excavation confirmation samples for cadmium analysis were collected from the excavation sidewalls. The initial approach to implementing the cleanup level for the site was to excavate the sidewall soil such that the residual soil cadmium concentration does not exceed the cleanup level. Therefore, when excavation sidewall soil cadmium levels exceed the soil cleanup level, additional soil was excavated and the sidewall sampled again. Some locations were re-excavated three times.

The soil excavation confirmation samples are composite soil samples collected from the sidewall at intervals of 25 feet on center. At each sample location, the composite sample was prepared by obtaining soil aliquots at a 2-foot interval along a vertical transect from the bottom to top of excavation. Typically the length of the vertical transect ranges from 6 to 14 feet, therefore the number of soil aliquots typically obtained from each sample location ranges from four to eight.

A total of 34 sidewall locations were sampled; 17 each from the eastern and western excavation sidewalls as shown in Drawing 1. The residual cadmium concentrations in the excavation sidewall soils based on samples collected as of August 18, 2006 are provided in Table 1 (attached). The mean cadmium soil concentration for the 34 sample locations is 0.95 mg/kg; the results range from a less-than–detection-limit value (non detect) to a maximum value of 6.2 mg/kg. The result for one location exceeds the 2.55 mg/kg cadmium soil concentration cleanup level. Non detect results were recorded for 12 locations (35 percent of results).

Statistical Analysis

To determine whether the lateral extent of the Lagoon 2 Area excavation has attained the required clean up level, a statistical analysis of the sidewall soil sample results was performed. The approach is based on the assumption that most of the soil exceeding the cleanup level, including the soil with the highest cadmium concentrations, has been excavated such that the upper confidence limit (UCL) of the mean cadmium concentration in the remaining soil is at or below the cleanup level. The 95 percent UCL equals or exceeds the true mean 95 percent of the time. The 95 percent UCL of the arithmetic mean accounts for the uncertainty in estimating the true mean of an environmental data set and provides reasonable confidence that the true mean will not be underestimated.

Statistical methods for determining whether the mean concentration of the site is less than a cleanup standard presented in Methods for Evaluating the Attainment of Cleanup Standards (EPA 230/02-89-042) Chapter 6 assume that the contaminant concentrations follow a normal distribution, and calculate an upper confidence limit (UCL) based on the Students-t statistic. The Lagoon 2 Area excavation sidewall soil cadmium concentration data set was analyzed using a TtNUS-modified version of EPA's ProUCL (Version 3.00.02, August 2004) software. This software calculates the 95 percent UCLs using 15 different computation methods, 5 parametric and 10 non-parametric. ProUCL then suggests which UCL is most appropriate for the data set.

Using the mean as the basis of comparison to the cleanup level involved the following procedures for handling certain data such as duplicate results, replicate results, less-than–detection-limit results, and outliers.

Replicate and duplicate sample results were averaged.

Values reported as being less less-than–detection-limit (non detects) were included in the analysis at the reporting detection limit.

All data not known to be in error was considered valid. No outliers were identified. The maximum soil cadmium concentration value is 6.2 mg/kg from a Lagoon 2 eastern sidewall sample location 25 (L2-25). While the averaged composite sample result skews the data and appears to be an outlier, this value is not known to be in error and was thus considered valid for the purpose of the analysis.

<u>Results</u>
The Lagoon 2 Area excavation soil cadmium data statistical analysis results are summarized below.

Variable	cadmium (mg/kg)
Number of Valid Samples	34
Number of Unique Samples	24
Minimum	0.15
Maximum	6.2
Mean	0.95
Median	0.5
Standard Deviation	1.15
Variance	1.33
Coefficient of Variation	1.22
Skewness	3.20
Chebyshev UCL	1.81

According to ProUCL, the Lagoon 2 Area excavation confirmation cadmium soil data does not follow a normal distribution. ProUCL determined, based on goodness of fit tests, that the data follows a Chebyshev distribution and therefore the Chebyshev UCL is, therefore, a more appropriate UCL to use for evaluating the attainment of the cleanup standard. The calculated mean of the Lagoon 2 Area excavation confirmation cadmium soil data is 0.95 mg/kg and the 95 percent Chebyshev UCL is 1.81 mg/kg. It should be noted that the Chebyshev UCL (1.81) calculated by ProUCL is higher than the Students-t UCL (1.28).

Conclusion
The calculated mean of cadmium analytical results for 34 Lagoon 2 Area excavation sidewall confirmation soil sample locations is 0.95 mg/kg, which indicates that the 2.55 mg/kg cleanup level has been attained. To account for the uncertainty in estimating the true mean of the data set the 95 percent UCL for this data set was calculated using ProUCL, an EPA statistical software program. ProUCL found that the data set does not follow a normal distribution and determined that the Chebyshev 95 percent UCL of 1.81 mg/kg provides the most appropriate UCL. Based on this analysis, it can be stated that the true mean of the Lagoon 2 Area excavation sidewall soil cadmium concentration is probably equal to or less than 1.81 mg/kg. This value is somewhat less than the cleanup level of 2.55 mg/kg. Therefore, the statistical analysis result indicates, with reasonable assurance, that the cleanup level for the NHPC Site Lagoon 2 Area excavation sidewall is attained.

References

Singh, Anita. 2004. Computation of an Upper Confidence Limit of the Unknown Population Mean Using Software ProUCL, Version 3. Lockheed Martin Environmental Services. Paper Presented at a workshop for EPA's Technical Support Center for Monitoring and Site Characterization, Office of Research and Development, Las Vegas, Nevada.

US Environmental protection Agency, 1989. Methods for Evaluating the Attainment of Cleanup Standards (EPA 230/02-89-042). February 1989.

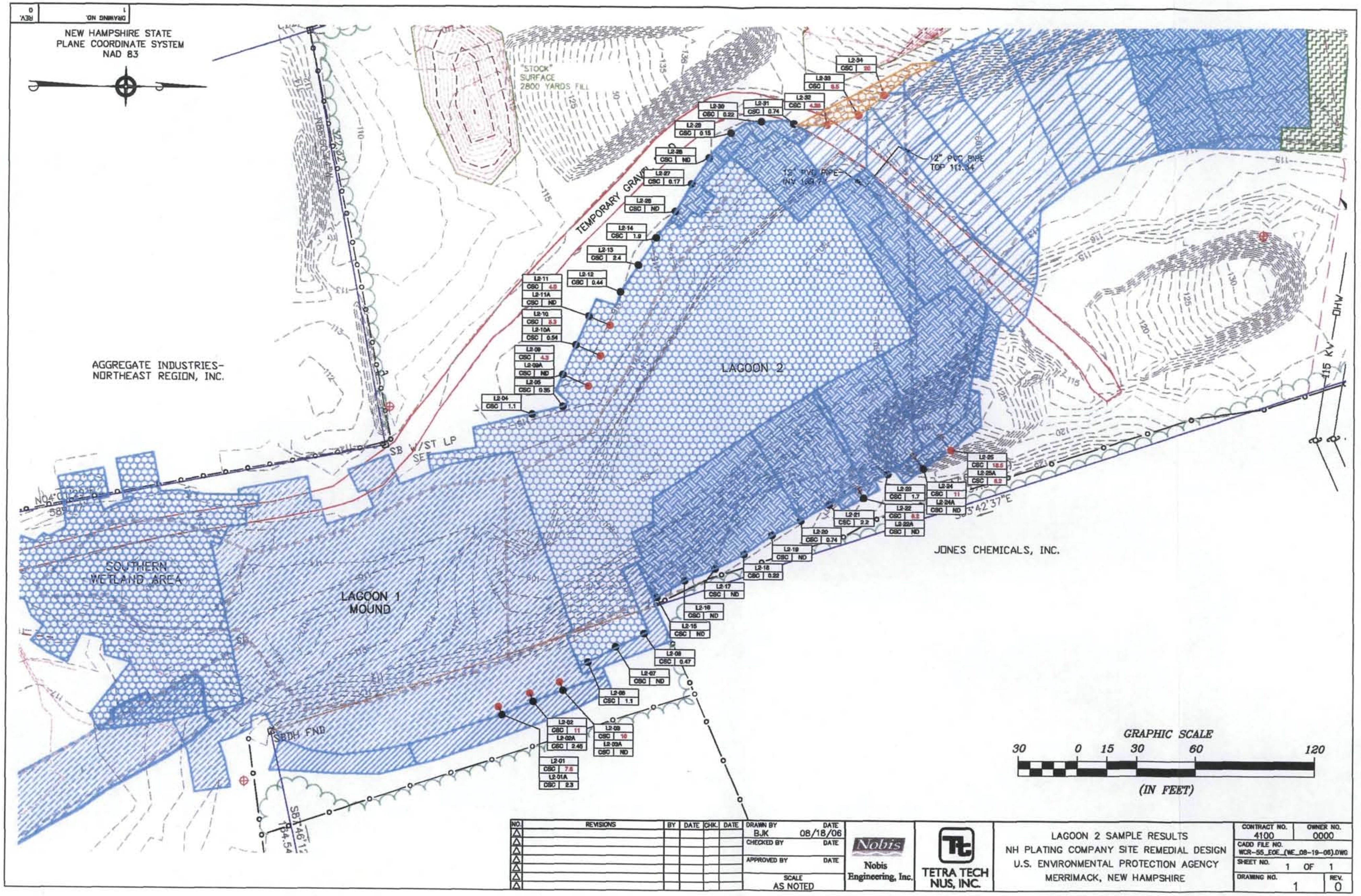
ProUCL Version 3.0 User Guide, April 2004. Authors: Anita Singh, Lockheed Martin Environmental Services; Ashok K. Singh, University of Nevada; and Robert W. Maichle, Lockheed Martin Environmental Services.

Table 1
Lagoon 2 Area Soil Excavation Sample Cadmium Results
Phase II Remedial Action (Soil Remediation), New Hampshire Plating Site, Merrimack, NH

Excavation Area	Sample Location ID	Cadmium (mg/kg)	Comments
Lagoon 2	NHP-L2-01A	2.3	
	NHP-L2-02A	3.2	
	NHP-L2-02A-1	1.7	NHP-L2-02A-1 replicate
	NHP-L2-03A	0.45 U	
	NHP-L2-04	1.1	
	NHP-L2-05	0.35 J	
	NHP-L2-06	1.1	
	NHP-L2-07	0.44 U	
	NHP-L2-08	0.47	
	NHP-L2-09A	0.5 U	
	NHP-L2-10A	0.54	
	NHP-L2-11A	0.5 U	
	NHP-L2-12	0.44 J	
	NHP-L2-13	2.4	
	NHP-L2-14	1.9	
	NHP-L2-15	0.53 U	
	NHP-L2-DUP03	0.53 U	NHP-L2-15 duplicate
	NHP-L2-16	0.5 U	
	NHP-L2-17	0.47 U	
	NHP-L2-18	0.22 J	
	NHP-L2-19	0.48 U	
	NHP-L2-20	0.74	
	NHP-L2-21	2.2	
	NHP-L2-22A	0.48 U	
	NHP-L2-23	1.7	
	NHP-L2-24A	0.5 U	
	NHP-L2-25A	6.2	
	NHP-L2-26	0.51 U	
	NHP-L2-27	0.17 J	
	NHP-L2-28	0.52 U	
	NHP-L2-29	0.15 J	
	NHP-L2-30	0.22 J	
	NHP-L2-31	0.74	
	NHP-L2-32A	0.34 J	
	NHP-L2-33A	0.27 J	
	NHP-L2-34A	0.34 J	

Laboratory: Alpha Analytical
Notes:
Results exceeding cleanup level indicated by black background.
Alpha character following location number designates re-excavation sample; "A" designates first re-excavation, "B" designates second re-excavation and "C" designates third re-excavation.
Numerical character following location number designates replicate sample; "1" designates first replicate sample and '2" designates second replicate sample.

J	estimated positive result above MDL but below RDL
L2	Lagoon 2 Area
MDL	method detection limit
mg/kg	milligram per kilogram
NA	not applicable
U	not detected at or above the MDL and presented at the level of the laboratory RDL
RDL	reporting detection limit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NORTHEAST REGION, INC.
LAGOON 2
SOUTHERN
WETLAND AREA
LAGOON 1
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115 KV
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LAGOON 2 SAMPLE RESULTS
NH PLATING COMPANY SITE REMEDIAL DESIGN
U.S. ENVIRONMENTAL PROTECTION AGENCY
MERRIMACK, NEW HAMPSHIRE
CONTRACT NO. 4100
OWNER NO. 0000
SHEET NO. 1 OF 1
DRAWING NO. 1
REV. 0

APPENDIX A-3

FORMER BUILDING AREA
EXCAVATION CONFIRMATION SOIL SAMPLE RESULTS EVALUATION

FORMER BUILDING AREA
EXCAVATION CONFIRMATION SOIL SAMPLE RESULTS EVALUATION
PHASE II REMEDIAL ACTION (SOIL REMEDIATION)
NEW HAMPSHIRE PLATING SITE, MERRIMACK, NEW HAMPSHIRE
AUGUST 24, 2006

An evaluation of the Former Building Area excavation confirmation soil sample results for attainment of the cleanup level for the New Hampshire Plating Company Site (NHPC Site) soil remediation is presented below.

Cleanup Level

Cleanup levels for NHPC Site soils were established to protect the aquifer from soil leachate. The Excel-Crystal Ball Transport (ECTran) model was used to estimate residual soil levels that are not expected to impair future groundwater quality. Soil clean-up levels for cadmium were developed for each major source areas to account for variation in flow paths, hydrogeologic conditions and contaminant concentrations. The Former Building Area was modeled as one source area resulting in a cadmium soil cleanup level of 3.30 mg/kg.

The soil cadmium cleanup level is used to identify the contaminated soil areas of the NHPC Site that need to be excavated and treated, using the chemical fixation process, to prevent leaching of metals from treated soils when backfilled on-site.

Former Building Area Excavation Confirmation Sampling

In the southern area of the site where the Former Building Area is located groundwater levels were lower and in the excavation groundwater was encountered at approximately 104 feet, which was set as the target excavation elevation for that area.

The extent of the excavation encompasses the contaminated areas as identified by the remedial design drawings. Soil excavation confirmation samples for cadmium analysis were collected from the excavation sidewalls. The initial approach to implementing the cleanup level for the site was to excavate the sidewall soil such that the residual soil cadmium concentration does not exceed the cleanup level. Therefore, when excavation sidewall soil cadmium levels exceed the soil cleanup level, additional soil was excavated and the sidewall sampled again. Some locations have been re-excavated twice.

The soil excavation confirmation samples are composite soil samples collected from the sidewall at intervals of 25 feet on center. At each sample location, the composite sample was prepared by obtaining soil aliquots at a 2-foot interval along a vertical transect from the bottom to top of excavation. Typically the length of the vertical transect ranges from 16 to 20 feet, therefore the number of soil aliquots typically obtained from each sample location ranges from nine to eleven.

A total of 21 sidewall locations were sampled from the four excavation sidewalls as shown in Drawing 1. The residual cadmium concentrations in the excavation sidewall soils based on samples collected as of August 17, 2006 are provided in Table 1 (attached). The mean cadmium soil concentration for the 17 sample locations is 1.37 mg/kg; the results range from a less-than–detection-limit value (non detect) to a maximum value being 5.4 mg/kg. Results for three locations exceed the 3.3 mg/kg cadmium soil concentration cleanup level. Non detect results were recorded for four locations (19 percent of results).

Statistical Analysis

To determine whether the lateral extent of the Former Building Area excavation has attained the required clean up level, a statistical analysis of the sidewall soil sample results was performed. The approach is based on the assumption that most of the soil exceeding the cleanup level, including the soil with the highest cadmium concentrations, has been excavated such that the upper confidence limit (UCL) of the mean cadmium concentration in the remaining soil is at or below the cleanup level. The 95 percent UCL equals or exceeds the true mean 95 percent of the time. The 95 percent UCL of the arithmetic mean accounts for the uncertainty in estimating the true mean of an environmental data set and provides reasonable confidence that the true mean will not be underestimated.

Statistical methods for determining whether the mean concentration of the site is less than a cleanup standard presented in Methods for Evaluating the Attainment of Cleanup Standards (EPA 230/02-89-042) Chapter 6 assume that the contaminant concentrations follow a normal distribution, and calculate an upper confidence limit (UCL) based on the Students-t statistic. The Lagoon 3 & 4 Area excavation sidewall soil cadmium concentration data set was analyzed using a TtNUS-modified version of EPA's ProUCL (Version 3.00.02, August 2004) software. This software calculates the 95 percent UCLs using 15 different computation methods, 5 parametric and 10 non-parametric. ProUCL then suggests which UCL is most appropriate for the data set.

Using the mean as the basis of comparison to the cleanup level involved the following procedures for handling certain data such as duplicate results, replicate results, less-than–detection-limit results, and outliers.

Replicate and duplicate sample results were averaged.

Values reported as being less less-than–detection-limit (non detects) were included in the analysis at the reporting detection limit.

All data not known to be in error was considered valid. No outliers were identified. The maximum soil cadmium concentration value is 5.4 mg/kg from Former Building Area northern excavation sidewall sample location 17 (BA-17). This value is not known to be in error and was thus considered valid for the purpose of the analysis.

In addition, the cadmium result for sample location BA-19 was not included the evaluation because this sample location is in portion of the excavation sidewall that is a common boundary between the Former Building Area and the Discharge Pipe Area (another area of concern) and will be excavated.

<u>Results</u>

The Former Building Area excavation soil cadmium data statistical analysis results are summarized below.

Variable	cadmium (mg/kg)
Number of Valid Samples	21
Number of Unique Samples	21
Minimum	0.058
Maximum	5.4
Mean	1.37
Median	0.53
Standard Deviation	1.51
Variance	2.27
Coefficient of Variation	1.10
Skewness	1.40
Approximate Gamma UCL	2.16

According to ProUCL, the Former Building Area excavation confirmation cadmium soil data does not follow a normal distribution. ProUCL determined, based on goodness of fit tests, that the data follows a gamma distribution and therefore the approximate gamma UCL is, therefore, a more appropriate UCL to use for evaluating the attainment of the cleanup standard. The calculated mean of the Former Building Area excavation confirmation cadmium soil data is 1.37 mg/kg and the 95 percent gamma UCL is 2.16 mg/kg. It should be noted that the approximate gamma UCL (2.16) calculated by ProUCL is slightly higher than the Students-t UCL (1.94).

Conclusion

The calculated mean of cadmium analytical results for 39 Former Building Area excavation sidewall confirmation soil sample locations is 1.37 mg/kg, which indicates that the 3.30 mg/kg cleanup level has been attained. To account for the uncertainty in estimating the true mean of the data set the 95 percent UCL for this data set was calculated using ProUCL, an EPA statistical software program. ProUCL found that the data set does not follow a normal distribution and determined that the approximate gamma UCL of 2.16 mg/kg provides the most appropriate UCL. Based on this analysis, it can be stated that the true mean of the Former Building Area excavation sidewall soil cadmium concentration is probably equal to or less than 2.16 mg/kg, which is less than the cleanup level of 3.30 mg/kg. Therefore, the statistical analysis result indicates, with reasonable assurance, that the cleanup level for the NHPC Site Former Building Area excavation sidewall is attained.

References

Singh, Anita. 2004. Computation of an Upper Confidence Limit of the Unknown Population Mean Using Software ProUCL, Version 3. Lockheed Martin Environmental Services. Paper Presented at a workshop for EPA's Technical Support Center for Monitoring and Site Characterization, Office of Research and Development, Las Vegas, Nevada.

US Environmental protection Agency, 1989. Methods for Evaluating the Attainment of Cleanup Standards (EPA 230/02-89-042). February 1989.

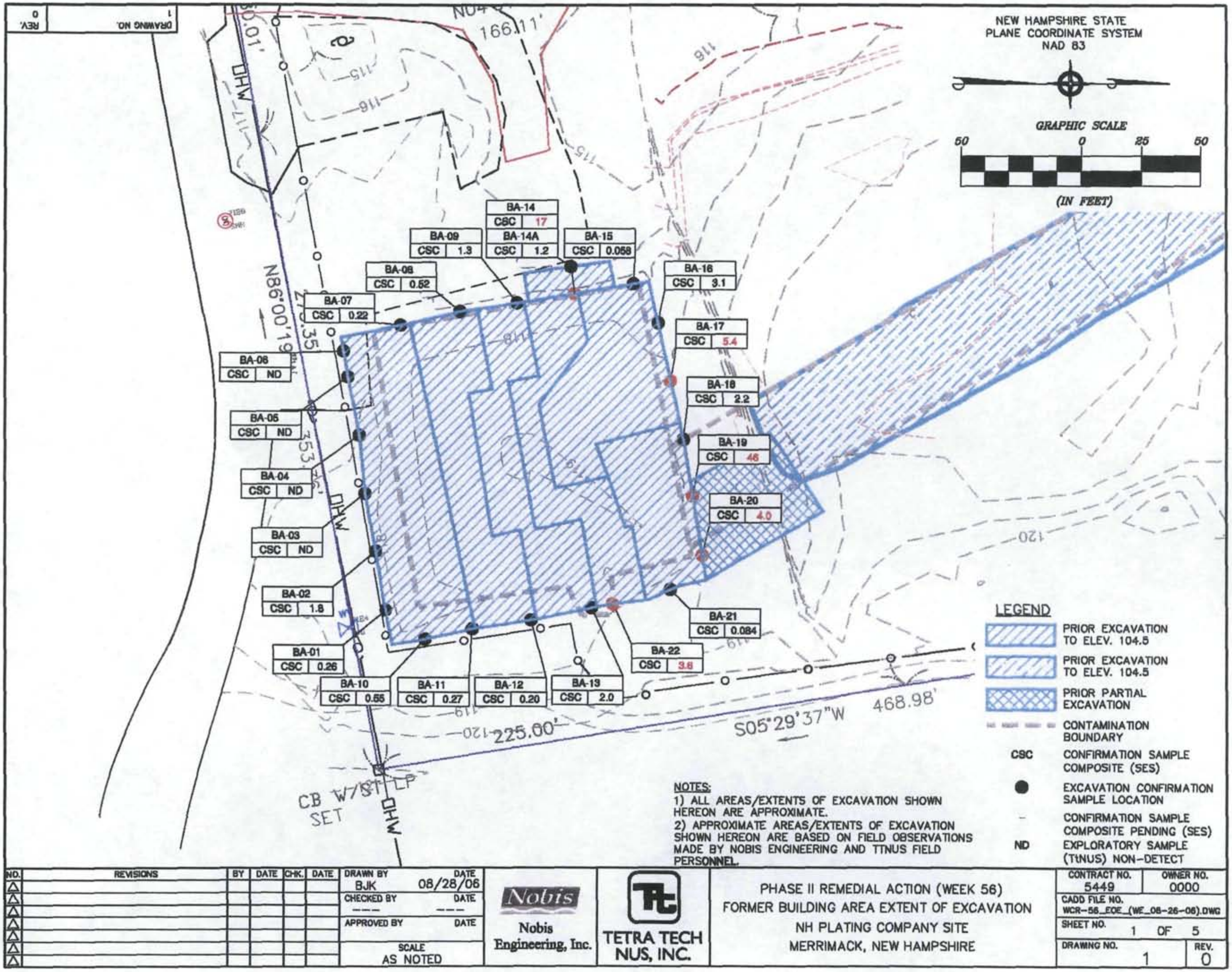
ProUCL Version 3.0 User Guide, April 2004. Authors: Anita Singh, Lockheed Martin Environmental Services; Ashok K. Singh, University of Nevada; and Robert W. Maichle, Lockheed Martin Environmental Services.

Table 1
Former Building Area Soil Excavation Sample Cadmium Results
Phase II Remedial Action (Soil Remediation), New Hampshire Plating Site, Merrimack, NH

Excavation Area	Sample Location ID	Cadmium (mg/kg)		Comments
Former Building Area	NHP-BA-01	0.26	J	
	NHP-BA-02	1.8		
	NHP-BA-03	0.45	U	
	NHP-BA-04	0.53	U	
	NHP-BA-05	0.5	U	
	NHP-BA-06	0.49	U	
	NHP-BA-DUP-01	0.49	U	NHP-BA-06 duplicate
	NHP-BA-07	0.22	J	
	NHP-BA-08	0.52		
	NHP-BA-09	1.3		
	NHP-BA-10	0.55		
	NHP-BA-11	0.27	J	
	NHP-BA-12	0.2	J	
	NHP-BA-13	2		
	NHP-BA-14A	1.2		
	NHP-BA-15	0.058	J	
	NHP-BA-16	3.1		
	NHP-BA-17	5.4		
	NHP-BA-18	2.2		
	NHP-BA-20	4		
	NHP-BA-DUP-02	4.1		NHP-BA-20 duplicate
	NHP-BA-21	0.084	J	
	NHP-BA-22	3.6		

Laboratory: Alpha Analytical
Notes:
Results exceeding cleanup level indicated by black background.
Alpha character following location number designates re-excavation sample; "A" designates first re-excavation, "B" designates second re-excavation and "C" designates third re-excavation.
Numerical character following location number designates replicate sample; "1" designates first replicate sample and '2" designates second replicate sample.

J	estimated positive result above MDL but below RDL
BA	Former Building Area
MDL	method detection limit
mg/kg	milligram per kilogram
NA	not applicable
U	not detected at or above the MDL and presented at the level of the laboratory RDL
RDL	reporting detection limit


NEW HAMPSHIRE STATE
PLANE COORDINATE SYSTEM
NAD 83
GRAPHIC SCALE
50 0 25 50
(IN FEET)
BA-14 CSC 17
BA-14A CSC 1.2
BA-09 CSC 1.3
BA-15 CSC 0.058
BA-08 CSC 0.52
BA-16 CSC 3.1
BA-07 CSC 0.22
BA-17 CSC 5.4
BA-06 CSC ND
BA-18 CSC 2.2
BA-05 CSC ND
BA-19 CSC 46
BA-04 CSC ND
BA-20 CSC 4.0
BA-03 CSC ND
BA-02 CSC 1.8
BA-21 CSC 0.084
BA-01 CSC 0.26
BA-22 CSC 3.8
BA-10 CSC 0.55
BA-11 CSC 0.27
BA-12 CSC 0.20
BA-13 CSC 2.0
166.11'
N86°00'19"
353.76'
DHW
225.00'
S05°29'37"W
468.98'
CB W/ST LP SET
LEGEND
PRIOR EXCAVATION TO ELEV. 104.5
PRIOR EXCAVATION TO ELEV. 104.5
PRIOR PARTIAL EXCAVATION
CONTAMINATION BOUNDARY
CSC CONFIRMATION SAMPLE COMPOSITE (SES)
EXCAVATION CONFIRMATION SAMPLE LOCATION
CONFIRMATION SAMPLE COMPOSITE PENDING (SES)
ND EXPLORATORY SAMPLE (TtNUS) NON-DETECT
NOTES:
1) ALL AREAS/EXTENTS OF EXCAVATION SHOWN HEREON ARE APPROXIMATE.
2) APPROXIMATE AREAS/EXTENTS OF EXCAVATION SHOWN HEREON ARE BASED ON FIELD OBSERVATIONS MADE BY NOBIS ENGINEERING AND TTNUS FIELD PERSONNEL.
DRAWN BY BJK DATE 08/28/06
CHECKED BY DATE
APPROVED BY DATE
SCALE AS NOTED
Nobis Engineering, Inc.
TETRA TECH NUS, INC.
PHASE II REMEDIAL ACTION (WEEK 56)
FORMER BUILDING AREA EXTENT OF EXCAVATION
NH PLATING COMPANY SITE
MERRIMACK, NEW HAMPSHIRE
CONTRACT NO. 5449
OWNER NO. 0000
CADD FILE NO. WCR-56_EOE_(WE_08-26-06).DWG
SHEET NO. 1 OF 5
DRAWING NO. 1
REV. 0

APPENDIX A-4

LAGOONS 3 & 4

EXCAVATION CONFIRMATION SOIL SAMPLE RESULTS EVALUATION

LAGOONS 3 & 4 AREA
EXCAVATION CONFIRMATION SOIL SAMPLE RESULTS EVALUATION
PHASE II REMEDIAL ACTION (SOIL REMEDIATION)
NEW HAMPSHIRE PLATING SITE, MERRIMACK, NEW HAMPSHIRE
SEPTEMBER 8, 2006

An evaluation of the Lagoons 3 & 4 Area excavation confirmation soil sample results for attainment of the cleanup level for the New Hampshire Plating Company Site (NHPC Site) soil remediation is presented below.

Cleanup Level

Cleanup levels for NHPC Site soils were established to protect the aquifer from soil leachate. The Excel-Crystal Ball Transport (ECTran) model was used to estimate residual soil levels that are not expected to impair future groundwater quality. Soil clean-up levels for cadmium were developed for each major source areas to account for variation in flow paths, hydrogeologic conditions and contaminant concentrations. Lagoons 3 & 4 Area was modeled as one source area resulting in a cadmium soil cleanup level of 2.42 mg/kg.

The soil cadmium cleanup level is used to identify the contaminated soil areas of the NHPC Site that need to be excavated and treated, using the chemical fixation process, to prevent leaching of metals from treated soils when backfilled on-site.

Lagoons 3 & 4 Area Excavation Confirmation Sampling

The Lagoons 3 & 4 area target excavation elevation was established at evaluation 106 feet (approximate water table elevation), based on groundwater elevations and depth of contamination.

The extent of the excavation encompasses the contaminated areas as identified by the remedial design drawings. Soil excavation confirmation samples for cadmium analysis were collected from the excavation sidewalls. The initial approach to implementing the cleanup level for the site was to excavate the sidewall soil such that the residual soil cadmium concentration does not exceed the cleanup level. Therefore, when excavation sidewall soil cadmium levels exceed the soil cleanup level, additional soil was excavated and the sidewall sampled again. Some locations have been re-excavated twice.

The soil excavation confirmation samples are composite soil samples collected from the sidewall at intervals of 25 feet on center. At each sample location, the composite sample was prepared by obtaining soil aliquots at a 2-foot interval along a vertical transect from the bottom to top of excavation. Typically the length of the vertical transect ranges from 6 to 14 feet, therefore the number of soil aliquots typically obtained from each sample location ranges from four to eight.

A total of 39 sidewall locations were sampled; 17 each from the eastern and western excavation sidewalls as shown in Drawing 1. The residual cadmium concentrations in the excavation sidewall soils based on samples collected as of August 29, 2006 are provided in Table 1 (attached). The mean cadmium soil concentration for the 39 sample locations is 0.89 mg/kg; the results range from a less-than–detection-limit value (non detect) to a maximum value being 4.5 mg/kg. Results for one location exceed the 2.42 mg/kg cadmium soil concentration cleanup level. Non detect results were recorded for 12 locations (31 percent of results).

Statistical Analysis

To determine whether the lateral extent of the Lagoons 3 & 4 Area excavation has attained the required clean up level, a statistical analysis of the sidewall soil sample results was performed. The approach is based on the assumption that most of the soil exceeding the cleanup level, including the soil with the highest cadmium concentrations, has been excavated such that the upper confidence limit (UCL) of the mean cadmium concentration in the remaining soil is at or below the cleanup level. The 95 percent UCL equals or exceeds the true mean 95 percent of the time. The 95 percent UCL of the arithmetic mean accounts for the uncertainty in estimating the true mean of an environmental data set and provides reasonable confidence that the true mean will not be underestimated.

Statistical methods for determining whether the mean concentration of the site is less than a cleanup standard presented in Methods for Evaluating the Attainment of Cleanup Standards (EPA 230/02-89-042) Chapter 6 assume that the contaminant concentrations follow a normal distribution, and calculate an upper confidence limit (UCL) based on the Students-t statistic. The Lagoon 3 & 4 Area excavation sidewall soil cadmium concentration data set was analyzed using a TtNUS-modified version of EPA's ProUCL (Version 3.00.02, August 2004) software. This software calculates the 95 percent UCLs using 15 different computation methods, 5 parametric and 10 non-parametric. ProUCL then suggests which UCL is most appropriate for the data set.

Using the mean as the basis of comparison to the cleanup level involved the following procedures for handling certain data such as duplicate results, replicate results, less-than–detection-limit results, and outliers.

Replicate and duplicate sample results were averaged.

Values reported as being less less-than–detection-limit (non detects) were included in the analysis at the reporting detection limit.

All data not known to be in error was considered valid. No outliers were identified. The maximum soil cadmium concentration value is 4.5 mg/kg from a Lagoons 3 & 4 western excavation sidewall sample location 22 (L3-22). While the averaged composite sample result skews the data and appears to be an outlier, this value is not known to be in error and was thus considered valid for the purpose of the analysis.

Results

The Lagoons 3 & 4 Area excavation soil cadmium data statistical analysis results are summarized below.

Variable	cadmium (mg/kg)
Number of Valid Samples	39
Number of Unique Samples	31
Minimum	0.044
Maximum	4.5
Mean	0.89
Median	0.5
Standard Deviation	0.92
Variance	0.84
Coefficient of Variation	1.03
Skewness	1.88
99 percent Chebyshev UCL	2.35

According to ProUCL, the Lagoons 3 & 4 Area excavation confirmation cadmium soil data does not follow a normal distribution. ProUCL determined, based on goodness of fit tests, that the data follows a Chebyshev distribution and therefore the 99 percent Chebyshev UCL is, therefore, a more appropriate UCL to use for evaluating the attainment of the cleanup standard. The calculated mean of the Lagoons 3 & 4 Area excavation confirmation cadmium soil data is 0.89 mg/kg and the 99 percent Chebyshev UCL is 2.35 mg/kg. It should be noted that the Chebyshev UCL (2.35) calculated by ProUCL is higher than the Students-t UCL (1.13).

Conclusion

The calculated mean of cadmium analytical results for 39 Lagoons 3 & 4 Area excavation sidewall confirmation soil sample locations is 0.89 mg/kg, which indicates that the 2.42 mg/kg cleanup level has been attained. To account for the uncertainty in estimating the true mean of the data set the 95 percent UCL for this data set was calculated using ProUCL, an EPA statistical software program. ProUCL found that the data set does not follow a normal distribution and determined that the Chebyshev 99 percent UCL of 2.35 mg/kg provides the most appropriate UCL. Based on this analysis, it can be stated that the true mean of the Lagoons 3 & 4 Area excavation sidewall soil cadmium concentration is probably equal to or less than 2.35 mg/kg. This value is slightly less than the cleanup level of 2.42 mg/kg. Therefore, the statistical analysis result indicates, with reasonable assurance, that the cleanup level for the NHPC Site Lagoons 3 & 4 Area excavation sidewall is attained.

References

Singh, Anita. 2004. Computation of an Upper Confidence Limit of the Unknown Population Mean Using Software ProUCL, Version 3. Lockheed Martin Environmental Services. Paper Presented at a workshop for EPA's Technical Support Center for Monitoring and Site Characterization, Office of Research and Development, Las Vegas, Nevada.

US Environmental protection Agency, 1989. Methods for Evaluating the Attainment of Cleanup Standards (EPA 230/02-89-042). February 1989.

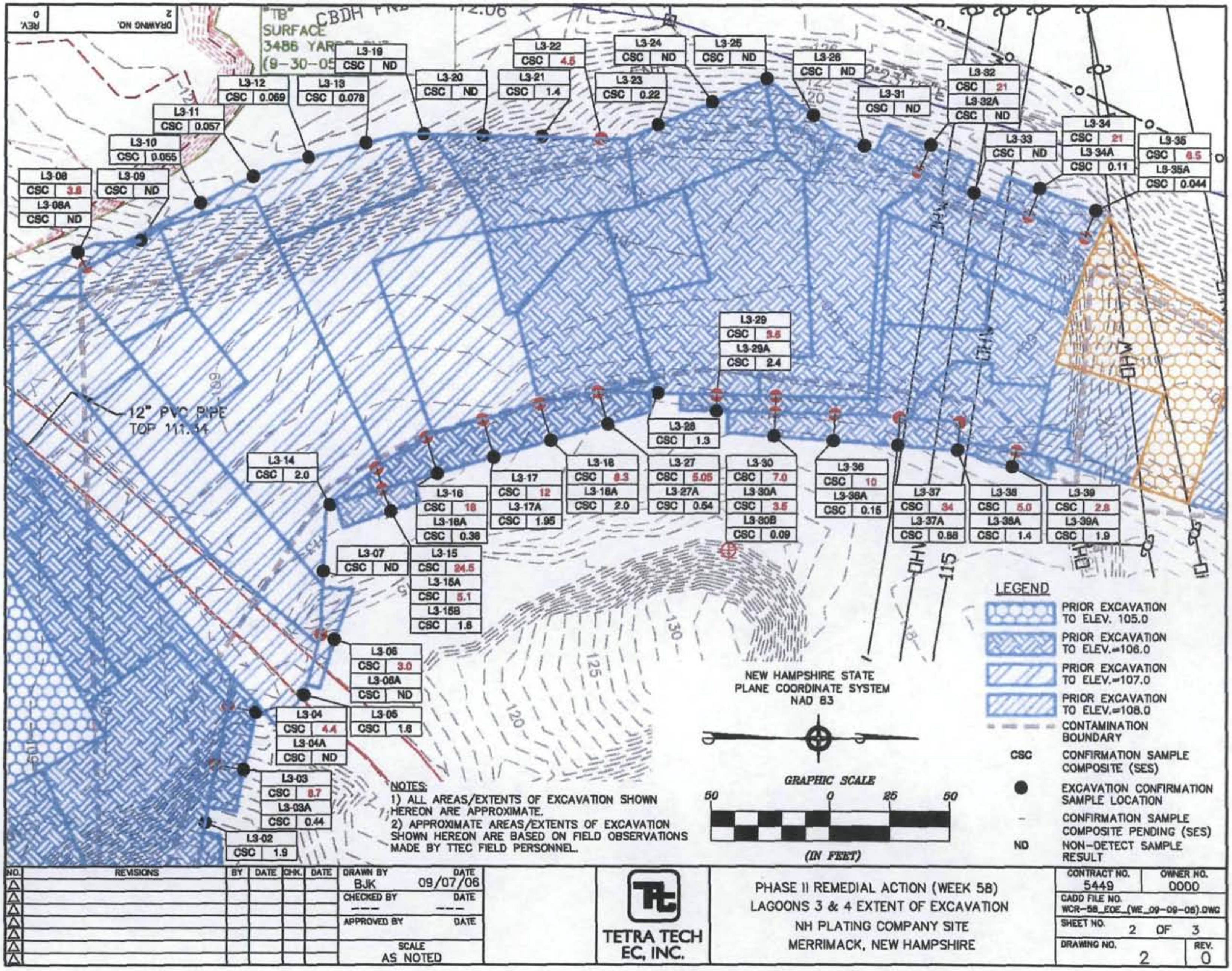
ProUCL Version 3.0 User Guide, April 2004. Authors: Anita Singh, Lockheed Martin Environmental Services; Ashok K. Singh, University of Nevada; and Robert W. Maichle, Lockheed Martin Environmental Services.

Table 1
Lagoons 3 & 4 Area Soil Excavation Sample Cadmium Results
Phase II Remedial Action (Soil Remediation), New Hampshire Plating Site, Merrimack, NH

Excavation Area	Sample Location ID	Cadmium (mg/kg)	Comments
Lagoons 3 & 4	NHP-L3-01A	1.3	
	NHP-L3-02	1.9	
	NHP-L3-03A	0.44 J	
	NHP-L3-04A	0.54 U	
	NHP-L3-DUP-01	0.1 J	NHP-L3-04A duplicate
	NHP-L3-05	1.6	
	NHP-L3-06A	0.52 U	
	NHP-L3-07	0.53 U	
	NHP-L3-08A	0.5 U	
	NHP-L3-09	0.49 U	
	NHP-L3-10	0.055 J	
	NHP-L3-11	0.057 J	
	NHP-L3-12	0.069 J	
	NHP-L3-13	0.078 J	
	NHP-L3-14	2	
	NHP-L3-15B	1.8	
	NHP-L3-16A	0.38 J	
	NHP-L3-17A	1.7	
	NHP-L3-DUP-05	2.2	NHP-L3-17A duplicate
	NHP-L3-18A	2.0	
	NHP-L3-19	0.44 U	
	NHP-L3-20	0.47 U	
	NHP-L3-21	1.4	
	NHP-L3-22	4.5	
	NHP-L3-23	0.22 J	
	NHP-L3-24	0.51 U	
	NHP-L3-25	0.49 U	
	NHP-L3-26	0.48 U	
	NHP-L3-27A	0.54	
	NHP-L3-28	1.3	
	NHP-L3-29A	2.4	
	NHP-L3-30B	0.09 J	
	NHP-L3-31	0.52 U	
	NHP-L3-32A	0.5 U	
	NHP-L3-33	0.46 U	
	NHP-L3-34A	0.11 J	
	NHP-L3-35A	0.044 J	
	NHP-L3-36A	0.15 J	
	NHP-L3-37A	0.88	
	NHP-L3-38A	1.4	
	NHP-L3-39A	1.9	

Laboratory: Alpha Analytical
Notes:
Results exceeding cleanup level indicated by black background.
Alpha character following location number designates re-excavation sample; "A" designates first re-excavation, "B" designates second re-excavation and "C" designates third re-excavation.
Numerical character following location number designates replicate sample; "1" designates first replicate sample and '2" designates second replicate sample.

J	estimated positive result above MDL but below RDL
L3	Lagoons 3 & 4 Area
MDL	method detection limit
mg/kg	milligram per kilogram
NA	not applicable
U	not detected at or above the MDL and presented at the level of the laboratory RDL
RDL	reporting detection limit


L3-02 CSC 1.9
L3-03 CSC 8.7
L3-03A CSC 0.44
L3-04 CSC 4.4
L3-04A CSC ND
L3-05 CSC 1.6
L3-06 CSC 3.0
L3-06A CSC ND
L3-07 CSC ND
L3-08 CSC 3.8
L3-08A CSC ND
L3-09 CSC ND
L3-10 CSC 0.055
L3-11 CSC 0.057
L3-12 CSC 0.069
L3-13 CSC 0.078
L3-14 CSC 2.0
L3-15 CSC 24.5
L3-15A CSC 5.1
L3-15B CSC 1.8
L3-16 CSC 18
L3-16A CSC 0.38
L3-17 CSC 12
L3-17A CSC 1.95
L3-18 CSC 8.3
L3-18A CSC 2.0
L3-19 CSC ND
L3-20 CSC ND
L3-21 CSC 1.4
L3-22 CSC 4.5
L3-23 CSC 0.22
L3-24 CSC ND
L3-25 CSC ND
L3-26 CSC ND
L3-27 CSC 5.05
L3-27A CSC 0.54
L3-28 CSC 1.3
L3-29 CSC 3.6
L3-29A CSC 2.4
L3-30 CSC 7.0
L3-30A CSC 3.5
L3-30B CSC 0.09
L3-31 CSC ND
L3-32 CSC 21
L3-32A CSC ND
L3-33 CSC ND
L3-34 CSC 21
L3-34A CSC 0.11
L3-35 CSC 6.5
L3-35A CSC 0.044
L3-36 CSC 10
L3-36A CSC 0.15
L3-37 CSC 34
L3-37A CSC 0.88
L3-38 CSC 5.0
L3-38A CSC 1.4
L3-39 CSC 2.8
L3-39A CSC 1.9
"TB" SURFACE
3486 YARDS
12" PVC PIPE
TOP 111.34
130
125
120
115
NOTES:
1) ALL AREAS/EXTENTS OF EXCAVATION SHOWN HEREON ARE APPROXIMATE.
2) APPROXIMATE AREAS/EXTENTS OF EXCAVATION SHOWN HEREON ARE BASED ON FIELD OBSERVATIONS MADE BY TTEC FIELD PERSONNEL.
NEW HAMPSHIRE STATE PLANE COORDINATE SYSTEM NAD 83
GRAPHIC SCALE
50 0 25 50
(IN FEET)
LEGEND
PRIOR EXCAVATION TO ELEV. 105.0
PRIOR EXCAVATION TO ELEV.=106.0
PRIOR EXCAVATION TO ELEV.=107.0
PRIOR EXCAVATION TO ELEV.=108.0
CONTAMINATION BOUNDARY
CSC CONFIRMATION SAMPLE COMPOSITE (SES)
EXCAVATION CONFIRMATION SAMPLE LOCATION
CONFIRMATION SAMPLE COMPOSITE PENDING (SES)
ND NON-DETECT SAMPLE RESULT
NO. REVISIONS BY DATE CHK. DATE
DRAWN BY BJK DATE 09/07/06
CHECKED BY --- DATE ---
APPROVED BY DATE
SCALE AS NOTED
TETRA TECH EC, INC.
PHASE II REMEDIAL ACTION (WEEK 58)
LAGOONS 3 & 4 EXTENT OF EXCAVATION
NH PLATING COMPANY SITE
MERRIMACK, NEW HAMPSHIRE
CONTRACT NO. 5449
OWNER NO. 0000
CADD FILE NO. WCR-58_EOE_(WE_09-09-06).DWG
SHEET NO. 2 OF 3
DRAWING NO. 2
REV. 0

APPENDIX A-5

DISCHARGE PIPE AREA
EXCAVATION CONFIRMATION SOIL SAMPLE RESULTS EVALUATION

DISCHARGE PIPE AREA
EXCAVATION CONFIRMATION SOIL SAMPLE RESULTS EVALUATION
PHASE II REMEDIAL ACTION (SOIL REMEDIATION)
NEW HAMPSHIRE PLATING SITE, MERRIMACK, NEW HAMPSHIRE
SEPTEMBER 8, 2006

An evaluation of the Discharge Pipe Area (DPA) excavation confirmation soil sample results for attainment of the cleanup level for the New Hampshire Plating Company Site (NHPC Site) soil remediation is presented below.

Cleanup Level

The DPA is the location of a buried underground pipeline running between the former NHPC building footprint and Lagoon 1. When NHPC was operational plating process wastewater was gravity-drained from the operations building through this discharge pipe into Lagoon 1 located approximately 325 feet north of the building.

Cleanup levels for NHPC Site soils were established to protect the aquifer from soil leachate. The Excel-Crystal Ball Transport (ECTran) model was used to estimate residual soil levels that are not expected to impair future groundwater quality. Soil clean-up levels for cadmium were developed for each major source areas to account for variation in flow paths, hydrogeologic conditions and contaminant concentrations. However, since the pipe discharge area was located underneath the solidified material storage cell it could not be sampled and evaluated until the cell was demolished as part of the Phase I RA. The sampling performed after the cell was demolished showed that the former discharge pipe released some contamination and that this area was a source area requiring remediation.

The clean-up levels for cadmium range from 1.78 to 6.42 mg/kg, depending on the location of specific source areas. The Lagoon 1 and SWA cadmium clean-up level is 6.42 mg/kg, while the NHPC former building area cadmium clean-up level is 3.30 mg/kg. Since the flow paths and hydrogeologic conditions contaminant concentrations for the pipe discharge area are more similar to Lagoon 1 than the former building area it was determined that the Lagoon 1 clean-up levels are more appropriate that the former building clean-up levels.

The soil cadmium cleanup level is used to identify the contaminated soil areas of the NHPC Site that need to be excavated and treated, using the chemical fixation process, to prevent leaching of metals from treated soils when backfilled on-site.

Discharge Pipe Area Excavation Confirmation Sampling

DPA soils were excavated in a two-phase operation. In September 2005 the majority of the DPA, an approximately 300-foot long section beginning at Lagoon 1, was excavated to the groundwater table (elevation of approximately 105 feet). The southern section was under the temporary construction access road and could not be excavated. The excavation was approximately 40 feet in width with 1H: 1V sidewall slopes. Two plastic (PVC or HDPE) 4-inch diameter pipes were encountered at approximately 4 and 6 feet bgs respectively. The second phase of DPA excavation was conducted in September 2006 after the Former Building Area excavation was completed and when the temporary access road was no longer required for construction operations.

During both phases soil excavation confirmation samples for cadmium analysis were collected from the excavation sidewalls. The initial approach to implementing the cleanup level for the site was to excavate the sidewall soil such that the residual soil cadmium concentration does not exceed the cleanup level. Therefore, when excavation sidewall soil cadmium levels exceed the soil cleanup level, additional soil was excavated and the sidewall sampled again. One location have been re-excavated.

The soil excavation confirmation samples are composite soil samples collected from the sidewall at intervals of 25 feet on center. At each sample location, the composite sample was prepared by obtaining soil aliquots at a 2-foot interval along a vertical transect from the bottom to top of excavation. Typically the length of the vertical transect was 14 feet, therefore the number of soil aliquots typically obtained from each sample location was eight.

A total of 23 sidewall locations were sampled as shown in Drawing 1. However, sample results from only 19 sample locations (11 samples from the eastern sidewall and 8 samples form the western sidewall) was used in the evaluation because soils represented by four locations in the northern section of the DPA were removed by the Lagoon 1 and

SWA excavation. The residual cadmium concentrations in the excavation sidewall soils based on samples collected as of September 1, 2006 are provided in Table 1 (attached). The mean cadmium soil concentration for the 19 sample locations is 3.7 mg/kg; the results range from 0.94 mg/kg to a maximum value of 13 mg/kg. Only one location has a result exceeding the 6.42 mg/kg cadmium soil concentration cleanup level. No non detect results were recorded.

Statistical Analysis

To determine whether the lateral extent of the DPA excavation attained the required clean up level, a statistical analysis of the sidewall soil sample results was performed. The approach is based on the assumption that most of the soil exceeding the cleanup level, including the soil with the highest cadmium concentrations, has been excavated such that the upper confidence limit (UCL) of the mean cadmium concentration in the remaining soil is at or below the cleanup level. The 95 percent UCL equals or exceeds the true mean 95 percent of the time. The 95 percent UCL of the arithmetic mean accounts for the uncertainty in estimating the true mean of an environmental data set and provides reasonable confidence that the true mean will not be underestimated.

Statistical methods for determining whether the mean concentration of the site is less than a cleanup standard presented in Methods for Evaluating the Attainment of Cleanup Standards (EPA 230/02-89-042) Chapter 6 assume that the contaminant concentrations follow a normal distribution, and calculate an upper confidence limit (UCL) based on the Students-t statistic. The DPA excavation sidewall soil cadmium concentration data set was analyzed using a TtNUS-modified version of EPA's ProUCL (Version 3.00.02, August 2004) software. This software calculates the 95 percent UCLs using 15 different computation methods, 5 parametric and 10 non-parametric. ProUCL then suggests which UCL is most appropriate for the data set.

Using the mean as the basis of comparison to the cleanup level involved the following procedures for handling certain data such as duplicate results, replicate results, and outliers.

Replicate and duplicate sample results were averaged.

All data not known to be in error was considered valid. No outliers were identified. The maximum soil cadmium concentration value is 13 mg/kg from a the DPA eastern sidewall sample location 23 (PD -23). This location is near the north east corner for the former NHPC operations building. While the data appears to be an outlier, this value is not known to be in error and was thus considered valid for the purpose of the analysis.

Results

The DPA excavation soil cadmium data statistical analysis results are summarized below.

Variable	cadmium (mg/kg)
Number of Valid Samples	19
Number of Unique Samples	17
Minimum	0.94
Maximum	13
Mean	3.70
Median	3
Standard Deviation	2.79
Variance	7.79
Coefficient of Variation	0.76
Skewness	2.13
Approximate Gamma UCL	4.92

According to ProUCL, the DPA excavation confirmation cadmium soil data does not follow a normal distribution. ProUCL determined, based on goodness of fit tests, that the data follows a gamma distribution and therefore the approximate gamma UCL is, therefore, a more appropriate UCL to use for evaluating the attainment of the cleanup standard. The calculated mean of the DPA excavation confirmation cadmium soil data is 3.7 mg/kg and the 95 percent gamma UCL is 4.92 mg/kg. It should be noted that the approximate gamma UCL (4.92) calculated by ProUCL is slightly higher than the Students-t UCL (4.81).

According to the ProUCL Version 3.0 User Guide "Many positively skewed data sets follow a lognormal as well as a gamma distribution. Gamma distribution can be used to model positively skewed environmental data sets. It is observed that the use of a gamma distribution results in reliable and stable 95% UCL values. It is therefore, desirable to test if an environmental data set follows a gamma distribution. If a skewed data set does follow a gamma model, then a 95% UCL of the population mean should be computed using a gamma distribution."

Conclusion

The calculated mean of cadmium analytical results for 19 DPA excavation sidewall confirmation soil sample locations is 3.07 mg/kg, which indicates that the 6.42 mg/kg cleanup level has been attained. To account for the uncertainty in estimating the true mean of the data set the 95 percent UCL for this data set was calculated using ProUCL, an EPA statistical software program. ProUCL found that the data set does not follow a normal distribution and determined that the approximate gamma 95 percent UCL of 4.92 mg/kg provides the most appropriate UCL. Based on this analysis, it can be stated that the true mean of the DPA excavation sidewall soil cadmium concentration is probably equal to or less than 4.92 mg/kg. This value is significantly less than the cleanup level of 6.42 mg/kg. Therefore, the statistical analysis result indicates, with reasonable assurance, that the cleanup level for the NHPC Site DPA excavation sidewall is attained.

Reference

US Environmental protection Agency, 1989. Methods for Evaluating the Attainment of Cleanup Standards (EPA 230/02-89-042). February 1989.

US Environmental Protection Agency, 2002. Estimation of the Exposure Point Concentration Term Using a Gamma Distribution. Technology Support Center Issue. Office of Solid Waste and Emergency Response. EPA 600/R-02/084. October.

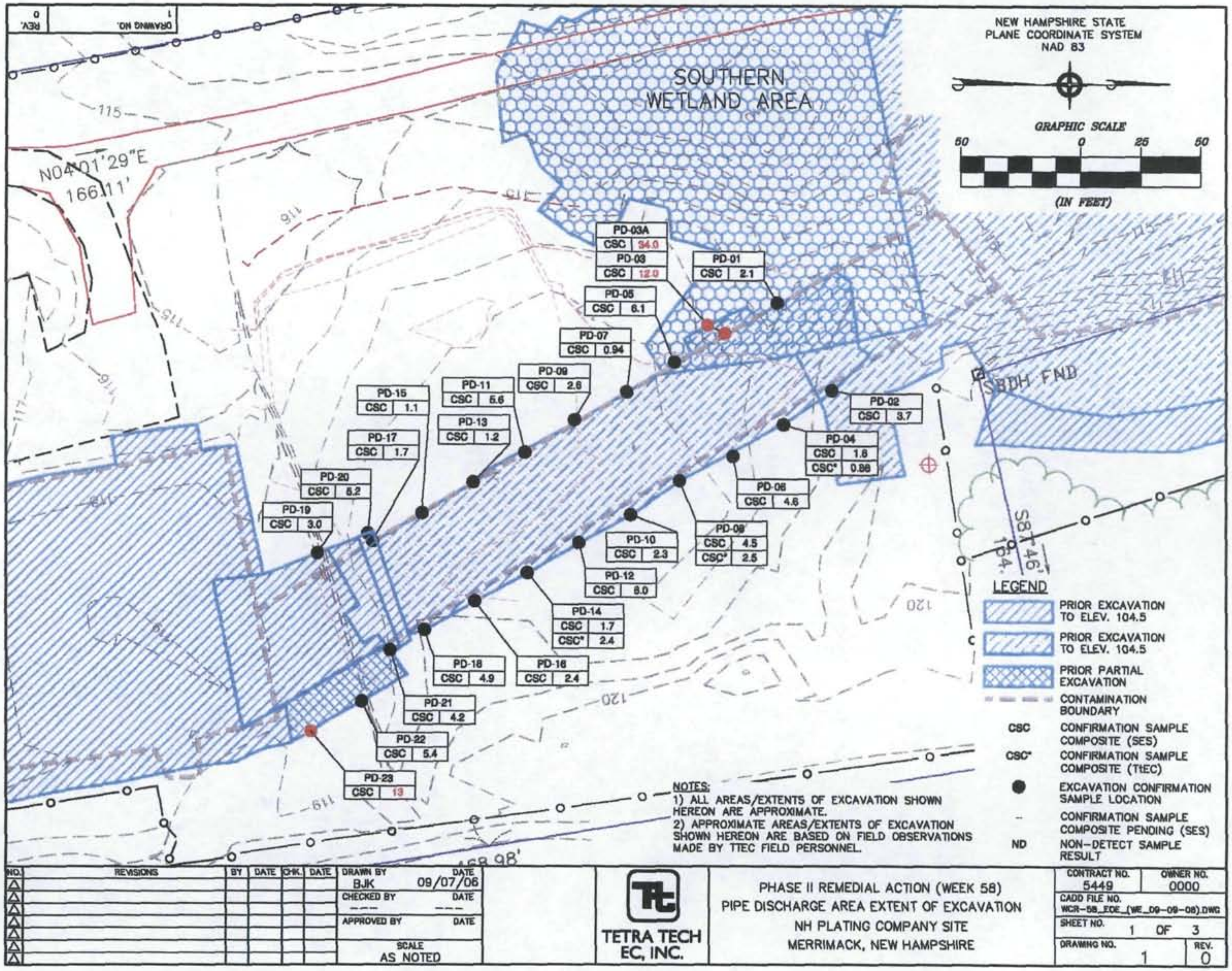
ProUCL Version 3.0 User Guide, April 2004. Authors: Anita Singh, Lockheed Martin Environmental Services; Ashok K. Singh, University of Nevada; and Robert W. Maichle, Lockheed Martin Environmental Services.

Table 1
Discharge Pipe Area (DPA) Soil Excavation Sample Cadmium Results
Phase II Remedial Action (Soil Remediation), New Hampshire Plating Site, Merrimack, NH

Excavation Area	Sample Location ID	Cadmium (mg/kg)	Comments
Discharge Pipe Area	PD-04	1.6	
	PD-06	4.6	
	PD-07	0.94	
	PD-08	3.5	
	PD-09	4.5	
	PD-08 DUP	2.5	PD-09 duplicate
	PD-10	2.3	
	PD-11	5.6	
	PD-12	6.0	
	PD-13	1.2	
	PD-14	1.7	
	PD-15	1.1	
	PD-16	2.4	
	PD-17	1.7	
	PD-18	4.9	
	PD-18 DUP	3.5	PD-18 duplicate
	NHP-PD-19	3.0	
	NHP-PD-20	5.2	
	NHP-PD-21	4.2	
	NHP-PD-22	5.4	
	NHP-PD-23	13	

Laboratory: Alpha Analytical
Notes:
Results exceeding cleanup level indicated by black background.
Alpha character following location number designates re-excavation sample; "A" designates first re-excavation, "B" designates second re-excavation and "C" designates third re-excavation.
Numerical character following location number designates replicate sample; "1" designates first replicate sample and '2" designates second replicate sample.

J	estimated positive result above MDL but below RDL
PD	Pipe Discharge Area
MDL	method detection limit
µg/L	micrograms per liter
NA	not applicable
U	not detected at or above the MDL and presented at the level of the laboratory RDL
RDL	reporting detection limit


NEW HAMPSHIRE STATE PLANE COORDINATE SYSTEM NAD 83
GRAPHIC SCALE
50 0 25 50
(IN FEET)
SOUTHERN WETLAND AREA
N04°01'29"E
166.11'
PD-03A CSC 34.0
PD-03 CSC 12.0
PD-01 CSC 2.1
PD-05 CSC 6.1
PD-07 CSC 0.94
PD-09 CSC 2.6
PD-11 CSC 5.6
PD-13 CSC 1.2
PD-15 CSC 1.1
PD-17 CSC 1.7
PD-20 CSC 5.2
PD-19 CSC 3.0
PD-02 CSC 3.7
PD-04 CSC 1.6 CSC* 0.86
PD-06 CSC 4.6
PD-08 CSC 4.5 CSC* 2.5
PD-10 CSC 2.3
PD-12 CSC 6.0
PD-14 CSC 1.7 CSC* 2.4
PD-16 CSC 2.4
PD-18 CSC 4.9
PD-21 CSC 4.2
PD-22 CSC 5.4
PD-23 CSC 13
SBDH FND
LEGEND
PRIOR EXCAVATION TO ELEV. 104.5
PRIOR EXCAVATION TO ELEV. 104.5
PRIOR PARTIAL EXCAVATION
CONTAMINATION BOUNDARY
CSC CONFIRMATION SAMPLE COMPOSITE (SES)
CSC* CONFIRMATION SAMPLE COMPOSITE (TtEC)
EXCAVATION CONFIRMATION SAMPLE LOCATION
- CONFIRMATION SAMPLE COMPOSITE PENDING (SES)
ND NON-DETECT SAMPLE RESULT
NOTES:
1) ALL AREAS/EXTENTS OF EXCAVATION SHOWN HEREON ARE APPROXIMATE.
2) APPROXIMATE AREAS/EXTENTS OF EXCAVATION SHOWN HEREON ARE BASED ON FIELD OBSERVATIONS MADE BY TTEC FIELD PERSONNEL.
REVISIONS
DRAWN BY BJK DATE 09/07/06
CHECKED BY
APPROVED BY
SCALE AS NOTED
TETRA TECH EC, INC.
PHASE II REMEDIAL ACTION (WEEK 58)
PIPE DISCHARGE AREA EXTENT OF EXCAVATION
NH PLATING COMPANY SITE
MERRIMACK, NEW HAMPSHIRE
CONTRACT NO. 5449
OWNER NO. 0000
CADD FILE NO. WCR-58_EOE_(WE_09-09-06).DWG
SHEET NO. 1 OF 3
DRAWING NO. 1
REV. 0

APPENDIX A-6

NORTHERN WETLAND AREA
EXCAVATION CONFIRMATION SOIL SAMPLE RESULTS EVALUATION

NORTHERN WETLAND AREA
EXCAVATION CONFIRMATION SOIL SAMPLE RESULTS EVALUATION
PHASE II REMEDIAL ACTION (SOIL REMEDIATION)
NEW HAMPSHIRE PLATING SITE, MERRIMACK, NEW HAMPSHIRE
SEPTEMBER 16, 2006

An evaluation of the Northern Wetland Area (NWA) excavation confirmation soil sample results for attainment of the cleanup level for the New Hampshire Plating Company Site (NHPC Site) soil remediation is presented below.

Cleanup Level

Cleanup levels for NHPC Site soils were established to protect the aquifer from soil leachate. The Excel-Crystal Ball Transport (ECTran) model was used to estimate residual soil levels that are not expected to impair future groundwater quality. Soil clean-up levels for cadmium were developed for each major source areas to account for variation in flow paths, hydrogeologic conditions and contaminant concentrations. Modeling of the NWA resulted in a cadmium soil cleanup level of 1.78 mg/kg.

In addition to groundwater protection, a NHPC Site soil remediation goal is to prevent contact by ecological receptors with soils having contaminant concentrations exceeding the ecological risk-based performance remedial goals (PRGs). A soil cleanup level based on protection of environmental receptors of 5.6 mg/kg cadmium was established for all areas.

After excavation to the extent practicable was completed it was determined that meeting the groundwater protection based clean up level (1.78 mg/kg) would require excessive additional cost and result in minimal benefit. Even though the groundwater protection based cleanup level (1.78 mg/kg) could not be achieved, the remediated site is protective of human health and the environment. The minimal amount of residual contaminated soil in the NWA potentially extends the MNA by some small length of time.

The soil cadmium cleanup level is used to identify the contaminated soil areas of the NHPC Site that need to be excavated and treated, using the chemical fixation process, to prevent leaching of metals from treated soils when backfilled on-site.

Discharge Pipe Area Excavation Confirmation Sampling

Based on groundwater elevations and depth of contamination, a target excavation elevation of 108 feet was established for the NWA. After completing the planned horizontal and vertical extents of excavation for the NWA, soil confirmation sampling revealed that the majority of samples collected from the excavation bottom (at elevation 108 feet) and sidewalls exceeded the NWA cleanup level of 1.78 mg/kg. Therefore, the NWA excavation was continued to an elevation of 107 feet and additional sidewall excavation at sample locations with cadmium levels above the cleanup level was performed to the extent practicable. Additional excavation at locations in the vicinity of power poles or guy wires, etc. was not conducted. Also, additional excavation of sidewall locations that would destabilize the slope was avoided. Following excavation to elevation 107 feet no bottom excavation confirmation soil samples were required, as the groundwater level in the NWA was approximately 107.5 feet based on measurement of water level in the closest piezometer.

The soil excavation confirmation samples are composite soil samples collected from the sidewall at intervals of 25 feet on center. At each sample location, the composite sample was prepared by obtaining soil aliquots at a 2-foot interval along a vertical transect from the bottom to top of excavation. Typically the length of the vertical transect ranges from 6 to 14 feet, therefore the number of soil aliquots typically obtained from each sample location ranges from four to eight.

After excavation to the extent practicable was completed, preliminary NWA excavation sidewall confirmation soil sample statistical analysis indicated that the ecological based clean up level (5.6 mg/kg) could not be met without covering of some sidewall areas to prevent access by ecological receptors. Therefore, a partial cover was placed in the NWA over locations NW-14A, 20A and 44A where cadmium soil levels were significantly higher that the ecological clean up level.

A total of 44 sidewall locations were sampled as shown in Drawing 1. However, sample results for locations NW-14A, 20A and 44A as theses area were inaccessible after placement of the NWA partial cover. Therefore, results for 41 sample locations were used in this evaluation. The residual cadmium concentrations in the excavation sidewall soils based on samples collected as of September 13, 2006 are provided in Table 1 (attached). The mean cadmium soil concentration for the 41 sample locations is 2.06 mg/kg; the results range from

The results range from a less-than–detection-limit value (non detect) to a maximum value being 8.8 mg/kg. Results for three locations exceed the 5.6 mg/kg cadmium soil concentration cleanup level. Non detect results were recorded for three locations (7 percent of results).

Statistical Analysis

To determine whether the lateral extent of the NWA excavation has attained the required clean up level, a statistical analysis of the sidewall soil sample results was performed. The approach is based on the assumption that most of the soil exceeding the cleanup level, including the soil with the highest cadmium concentrations, has been excavated such that the upper confidence limit (UCL) of the mean cadmium concentration in the remaining soil is at or below the cleanup level. The 95 percent UCL equals or exceeds the true mean 95 percent of the time. The 95 percent UCL of the arithmetic mean accounts for the uncertainty in estimating the true mean of an environmental data set and provides reasonable confidence that the true mean will not be underestimated.

Statistical methods for determining whether the mean concentration of the site is less than a cleanup standard presented in Methods for Evaluating the Attainment of Cleanup Standards (EPA 230/02-89-042) Chapter 6 assume that the contaminant concentrations follow a normal distribution, and calculate an upper confidence limit (UCL) based on the Students-t statistic. The NWA excavation sidewall soil cadmium concentration data set was analyzed using a TtNUS-modified version of EPA's ProUCL (Version 3.00.02, August 2004) software. This software calculates the 95 percent UCLs using 15 different computation methods, 5 parametric and 10 non-parametric. ProUCL then suggests which UCL is most appropriate for the data set.

Using the mean as the basis of comparison to the cleanup level involved the following procedures for handling certain data such as duplicate results, replicate results, less-than–detection-limit results, and outliers.

Replicate and duplicate sample results were averaged.

Values reported as being less less-than–detection-limit (non detects) were included in the analysis at the reporting detection limit.

All data not known to be in error was considered valid. No outliers were identified. The maximum soil cadmium concentration value is 8.8 mg/kg from a NWA northern sidewall sample location 7 (NW-7A). This value is not known to be in error and was thus considered valid for the purpose of the analysis.

Results

The NWA excavation soil cadmium data statistical analysis results are summarized below.

Variable	cadmium (mg/kg)
Number of Valid Samples	41
Number of Unique Samples	36
Minimum	0.049
Maximum	8.8
Mean	2.06
Median	1.5
Standard Deviation	2.10
Variance	4.40
Coefficient of Variation	1.02
Skewness	1.98
Approximate Gamma UCL	2.72

According to ProUCL, the NWA excavation confirmation cadmium soil data does not follow a normal distribution. ProUCL determined, based on goodness of fit tests, that the data follows a gamma distribution and therefore the approximate gamma UCL is, therefore, a more appropriate UCL to use for evaluating the attainment of the cleanup standard. The calculated mean of the NWA excavation confirmation cadmium soil data is 2.06 mg/kg and the 95 percent gamma UCL is 2.72 mg/kg. It should be noted that the approximate gamma UCL (2.72) calculated by ProUCL is slightly higher than the Students-t UCL (2.62).

According to the ProUCL Version 3.0 User Guide "Many positively skewed data sets follow a lognormal as well as a gamma distribution. Gamma distribution can be used to model positively skewed environmental data sets. It is observed that the use of a gamma distribution results in reliable and stable 95% UCL values. It is therefore, desirable to test if an environmental data set follows a gamma distribution. If a skewed data set does follow a gamma model, then a 95% UCL of the population mean should be computed using a gamma distribution."

Conclusion

The calculated mean of cadmium analytical results for 41 NWA excavation sidewall confirmation soil sample locations is 2.06 mg/kg, which indicates that the 5.6 mg/kg cleanup level has been attained. To account for the uncertainty in estimating the true mean of the data set the 95 percent UCL for this data set was calculated using ProUCL, an EPA statistical software program. ProUCL found that the data set does not follow a normal distribution and determined that the approximate gamma 95 percent UCL of 2.72 mg/kg provides the most appropriate UCL. Based on this analysis, it can be stated that the true mean of the NWA excavation sidewall with partial cover soil cadmium concentration is probably equal to or less than 2.72 mg/kg. This value is significantly less than the cleanup level of 5.6 mg/kg. Therefore, the statistical analysis result indicates, with reasonable assurance, that the cleanup level for the NHPC Site NWA excavation sidewall is attained.

Reference

US Environmental protection Agency, 1989. Methods for Evaluating the Attainment of Cleanup Standards (EPA 230/02-89-042). February 1989.

US Environmental Protection Agency, 2002. Estimation of the Exposure Point Concentration Term Using a Gamma Distribution. Technology Support Center Issue. Office of Solid Waste and Emergency Response. EPA 600/R-02/084. October.

ProUCL Version 3.0 User Guide, April 2004. Authors: Anita Singh, Lockheed Martin Environmental Services; Ashok K. Singh, University of Nevada; and Robert W. Maichle, Lockheed Martin Environmental Services.

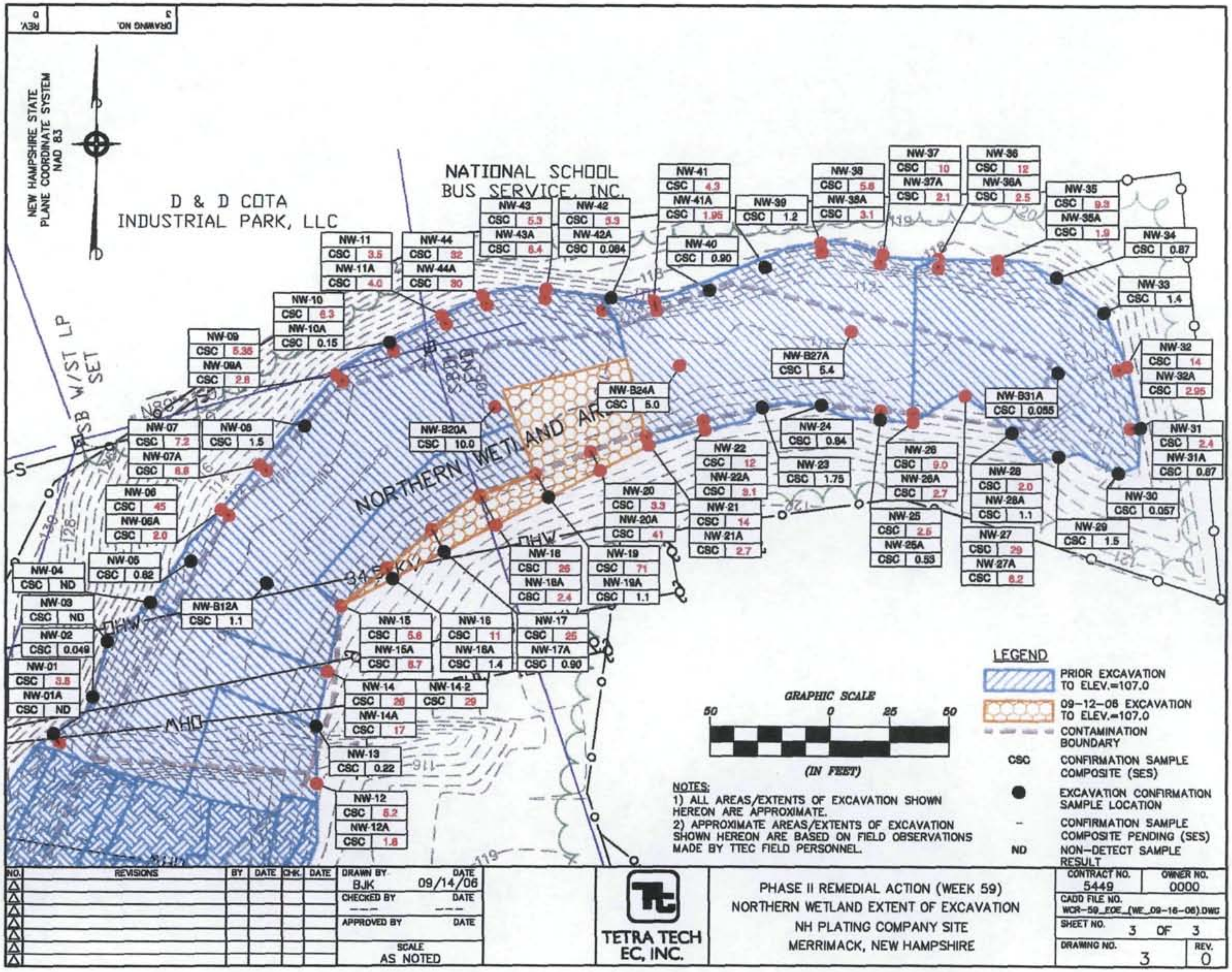
Table 1
Northern Wetland Area (NWA) Soil Excavation Sample Cadmium Results
Phase II Remedial Action (Soil Remediation), New Hampshire Plating Site, Merrimack, NH

Excavation Area	Sample Location ID	Cadmium (mg/kg)	Comments
NWA	NHP-NW-01A	0.47 U	
	NHP-NW-02	0.049 J	
	NHP-NW-03	0.52 U	
	NHP-NW-04	0.51 U	
	NHP-NW-05	0.62	
	NHP-NW-06A	2.0	
	NHP-NW-07A	8.8	
	NHP-NW-08	1.5	
	NHP-NW-09A	2.8	
	NHP-NW-10A	0.15 J	
	NHP-NW-11A	4.0	
	NHP-NW-12A	1.8	
	NHP-NW-13	0.22 J	
	NHP-NW-15A	8.7	
	NHP-NW-16A	1.4	
	NHP-NW-17A	0.9	
	NHP-NW-DUP-08	0.89	NHP-NW-17A duplicate
	NHP-NW-18A	2.4	
	NHP-NW-19A	1.1	
	NHP-NW-21A	2.7	
	NHP-NW-22A	3.1	
	NHP-NW-23	1.6	
	NHP-NW-DUP-02	1.9	NHP-NW-23 duplicate
	NHP-NW-24	0.84	
	NHP-NW-25A	0.53	
	NHP-NW-26A	2.7	
	NHP-NW-27A	6.2	
	NHP-NW-28A	1.1	
	NHP-NW-29	1.6	
	NHP-NW-DUP-03	1.4	NHP-NW-29 duplicate
	NHP-NW-30	0.057 J	
	NHP-NW-31A	0.87	
	NHP-NW-32A	3.1	
	NHP-NW-DUP-07	2.8	NHP-NW-32A duplicate
	NHP-NW-33	1.4	
	NHP-NW-34	0.87	
	NHP-NW-DUP-04	0.88	NHP-NW-34 duplicate
	NHP-NW-35A	1.9	
	NHP-NW-36A	2.5	
	NHP-NW-37A	2.1	
	NHP-NW-38A	3.1	
	NHP-NW-39	1.2	
	NHP-NW-40	0.9	
	NHP-NW-41A	2.1	
	NHP-NW-DUP-06	1.8	NHP-NW-41A duplicate
	NHP-NW-42A	0.084 J	
	NHP-NW-43A	6.4	

Laboratory: Alpha Analytical
Notes:
Results exceeding cleanup level indicated by black background.
Alpha character following location number designates re-excavation sample; "A" designates first re-excavation, "B" designates second re-excavation and "C" designates third re-excavation.
Numerical character following location number designates replicate sample; "1" designates first replicate sample and '2" designates second replicate sample.

J estimated positive result above MDL but below RDL
NW Northern Wetland Area
MDL method detection limit

µg/L	micrograms per liter
NA	not applicable
U	not detected at or above the MDL and presented at the level of the laboratory RDL
RDL	reporting detection limit


NEW HAMPSHIRE STATE PLANE COORDINATE SYSTEM NAD 83
D & D COTA INDUSTRIAL PARK, LLC
NATIONAL SCHOOL BUS SERVICE, INC.
NORTHERN WETLAND AREA
SB W/ST LP SET
NW-01 CSC 3.8 NW-01A CSC ND
NW-02 CSC 0.049
NW-03 CSC ND
NW-04 CSC ND
NW-05 CSC 0.62
NW-06 CSC 45 NW-06A CSC 2.0
NW-07 CSC 7.2 NW-07A CSC 6.8
NW-08 CSC 1.5
NW-09 CSC 5.35 NW-09A CSC 2.8
NW-10 CSC 6.3 NW-10A CSC 0.15
NW-11 CSC 3.5 NW-11A CSC 4.0
NW-12 CSC 5.2 NW-12A CSC 1.8
NW-13 CSC 0.22
NW-14 CSC 26 NW-14A CSC 17
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NW-19 CSC 71 NW-19A CSC 1.1
NW-20 CSC 3.3 NW-20A CSC 41
NW-21 CSC 14 NW-21A CSC 2.7
NW-22 CSC 12 NW-22A CSC 9.1
NW-23 CSC 1.75
NW-24 CSC 0.84
NW-25 CSC 2.5 NW-25A CSC 0.53
NW-26 CSC 9.0 NW-26A CSC 2.7
NW-27 CSC 29 NW-27A CSC 6.2
NW-28 CSC 2.0 NW-28A CSC 1.1
NW-29 CSC 1.5
NW-30 CSC 0.057
NW-31 CSC 2.4 NW-31A CSC 0.87
NW-32 CSC 14 NW-32A CSC 2.95
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NW-34 CSC 0.87
NW-35 CSC 9.3 NW-35A CSC 1.9
NW-36 CSC 12 NW-36A CSC 2.5
NW-37 CSC 10 NW-37A CSC 2.1
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NW-40 CSC 0.90
NW-41 CSC 4.3 NW-41A CSC 1.95
NW-42 CSC 3.3 NW-42A CSC 0.084
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NW-44 CSC 32 NW-44A CSC 30
NW-B12A CSC 1.1
NW-B20A CSC 10.0
NW-B24A CSC 5.0
NW-B27A CSC 5.4
NW-B31A CSC 0.055
GRAPHIC SCALE
50 0 25 50
(IN FEET)
LEGEND
PRIOR EXCAVATION TO ELEV.=107.0
09-12-06 EXCAVATION TO ELEV.=107.0
CONTAMINATION BOUNDARY
CSC CONFIRMATION SAMPLE COMPOSITE (SES)
EXCAVATION CONFIRMATION SAMPLE LOCATION
- CONFIRMATION SAMPLE COMPOSITE PENDING (SES)
ND NON-DETECT SAMPLE RESULT
NOTES:
1) ALL AREAS/EXTENTS OF EXCAVATION SHOWN HEREON ARE APPROXIMATE.
2) APPROXIMATE AREAS/EXTENTS OF EXCAVATION SHOWN HEREON ARE BASED ON FIELD OBSERVATIONS MADE BY TTEC FIELD PERSONNEL.
NO. REVISIONS BY DATE CHK. DATE
DRAWN BY BJK DATE 09/14/06
CHECKED BY DATE
APPROVED BY DATE
SCALE AS NOTED
TETRA TECH EC, INC.
PHASE II REMEDIAL ACTION (WEEK 59)
NORTHERN WETLAND EXTENT OF EXCAVATION
NH PLATING COMPANY SITE
MERRIMACK, NEW HAMPSHIRE
CONTRACT NO. 5449
OWNER NO. 0000
CADD FILE NO. WCR-59_EOE_(WE_09-16-06).DWG
SHEET NO. 3 OF 3
DRAWING NO. 3
REV. 0